# MACHINERY

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## STEEL LETTER STAMPING DIES

By CHESTER L. LUCAS*

THE making of steel letter stamping dies, for imprinting designs or lettering upon metal products, requires the knowledge of many interesting mechanical methods, and their set-up and operation differs from the general run of punch and die work in many respects. It is the purpose of this article to show the principles involved in marking both flat and round work, to illustrate some of the best methods of making a few types of steel letter stamping dies, and especially to give an outline of the work of cutting the letters. With the cooperation of Noble & Westbrook, of Hartford, Conn., a firm well-known to the machinery trade as a maker of steel letter stamping dies, we are enabled to give the readers of MACHINERY a description of this interesting work.

Fig. 1. Steel Letter Stamping Dies and Rolling Dies

The simplest forms of steel letter stamping dies are, of course, the single letters and figures that are in everyday use in the machine shop. From the single letter to the stamping die and from the hand-hammer to the power press, is but a step in the course of evolution.

Plain flat stamping dies for use in the power press are usually made with the raised letters engraved upon the punch, the die being simply a flat block of steel, held in a die shoe and fitted with a gage for the proper location of the work. In making or setting-up a flat stamping die, perhaps the most essential point outside of cutting the letters is to have the punch and die absolutely flat and exactly parallel with each other. The method usually employed in holding the stamping punch is by means of a shank turned to fit the hole bored in the ram of the press. The gage for locating the work may be a flat piece of sheet brass or iron, approximately ⅛ inch thick, held to the die with screws at the corners. The essential parts of a die of this kind are shown in Fig. 2. If the punch is large, it is held upon a punch plate which is, in turn, fastened to the ram of the press by four countersunk screws.

### Curved Surface Stamping Dies

While the piece shown in Fig. 5 might be lettered by rolling, it is very much simpler and quicker to do the lettering in a punch press, after the manner of flat stamping. To do this successfully, however, the surfaces of both the die and punch must be formed to fit the work closely. Wherever possible, the practical way of stamping a curved piece is to perform the operation while the blank is flat, afterward curving the metal to shape. With the piece shown in Fig. 5, this, of course, is impossible on account of the recess. Therefore, the radius of curvature of the blank to be stamped is scribed upon the side of the punch blank, and the steel shaped away close to this line, after which the punch is mounted upon the lathe faceplate and bored true to the scribed line. Similarly, the die is shaped and turned to conform to the under side of the blank. It is also necessary to mill a recess at the center, to clear the depressed part of the blank. From this point on, the making of this style of die is the same as with a flat stamping die, except that care must be taken to have the surfaces of the die and punch carefully fitted to the blank.

* Associate Editor of MACHINERY.

### Rolling Dies

Rolling dies may be of several different types: First, the roll may be mounted in a holder and rolled upon the work, which latter is placed on an arbor in the lathe; second, the roll is sometimes used in the reverse order, being itself held on an arbor in the lathe; third, one roll is used blank in connection with the lettering roll on special machines for rolling lettering, so that as the work passes between the two rolls,

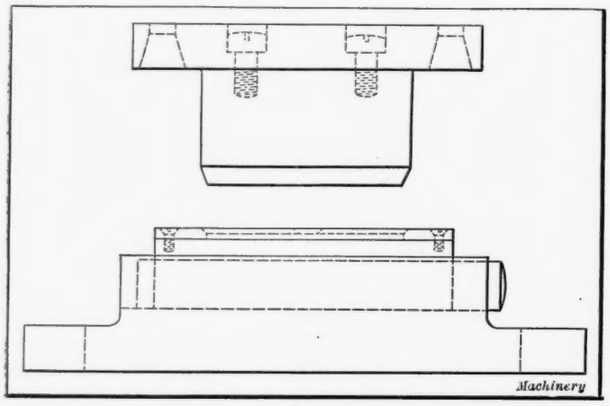



Fig. 2. Details of Die used for Stamping Flat Blanks

the letters are imprinted upon the surface of the work. Referring to Fig. 1, *D*, *J*, and *M* are rolling dies.

### Segment Dies

Segment dies are similar to rolling dies. The advantage of using the segment die is two-fold—it saves a large amount of the steel and labor required in making a solid roll, and reduces the liability of loss in hardening. At *P*, Fig. 1, is a roll in which segment dies are used. As some manufacturers use a great many different designs, the saving in steel is considerable if a segment die is used.

Another use for segment dies is in special lettering fixtures like the one shown in Fig. 3. In this instance the segment

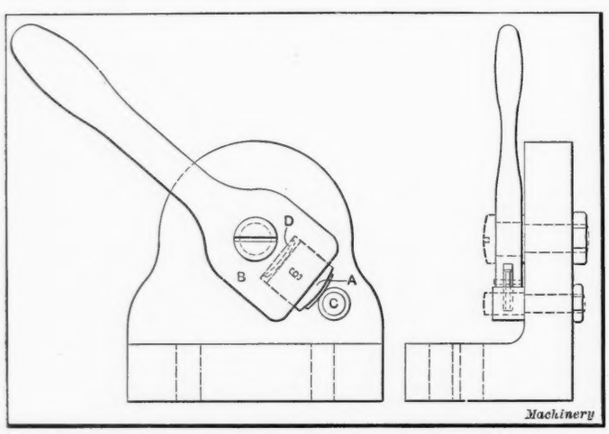



Fig. 3. Fixture used with Segment Dies for Lettering Tubes, etc.

die *A* which has the lettering on it is held in the casting *B*. The segment die is backed up by a spring *D* that tends to keep an even pressure upon the work that is being marked. In this way any irregularities in the work being marked are compensated for. The work is held upon the arbor *C*, and by moving the lever *B* forward, the lettering die is brought into contact with the work, and by means of the spring pressure the letters will be impressed into the surface of the work.

### A Type of Marking Machine

The illustration Fig. 6 shows one of the best methods of marking all classes of work, especially work that is other than flat sheet metal. There is no better way of marking sheet metal than in the punch press. The essential parts of a marking machine are the lower table *A* and the upper slide *B* which supports the die-holder *C*. The foot lever *D* is for raising the work high enough to allow the lettering to be imprinted to a sufficient depth. Adjustment for increasing or decreasing the depth of the letter is secured by means of screw *E*. The die is moved across the work by means of a hand-lever *F*. The machine is shown set up for marking chisels. All round work is marked with flat dies, and all flat work requires rolling dies; either the work or the die must roll. In this case, then, a rolling die is used. The roll is mounted on an arbor that is supported in die-holder *C*. Upon the outer end of this arbor, a gage is mounted. A pin on the side of the die-holder engages the semi-circular slot in this gage, and by means of spring *G*, the die is kept normally in the starting position. Hand lever *F* moves slide *B* forward, and consequently the letters on the rolling die are impressed into the chisels. As the roll passes over the work, the cord

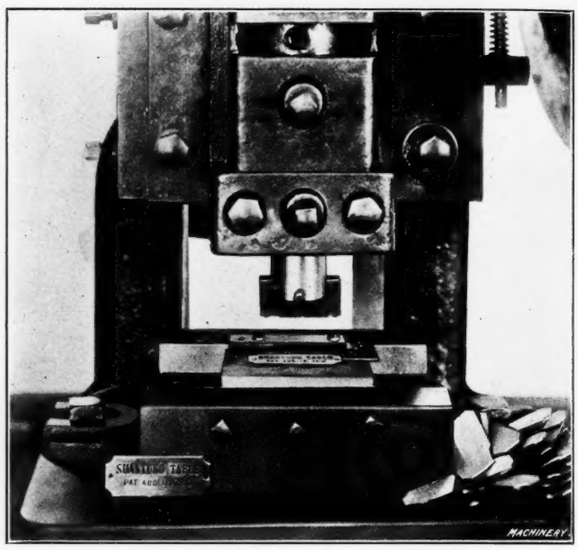



Fig. 4. Stamping Die used for Lettering Name-plate

attached to spring *G* is wound upon the arbor that carries the die, thus furnishing a means of returning the roll to its starting position when the operation is finished. The length of stroke of the table is regulated by screw *L*.

When it is desired to mark round work, such as taps, drills, or screw-drivers, a flat die-holder is substituted for roll-holder *C*. The piece is laid against a gage on table *A*, and the flat die passed over it, thus causing the work to roll. This marking machine is used in many factories whose product requires marking.

### Making the Dies

The work of cutting the letters upon the stamping dies, whether they are flat dies, rolling dies, or segment dies, is practically the same, except that rolling dies and segment dies are more difficult to make correctly. In machining the blank for a flat die, if there is to be more than one line of letters, the lines are separated by shaping, leaving them in the condition shown at *F* in Fig. 1, before going to the letter cutter. In the case of rolling dies, the same idea is carried

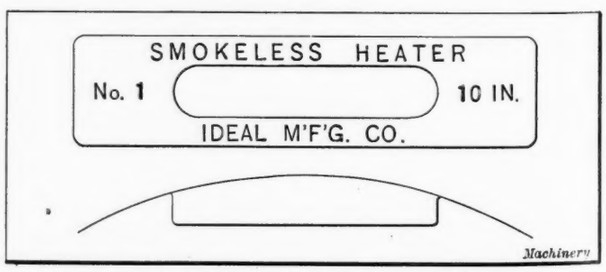



Fig. 5. Curved Name-plate that should be lettered after Forming

out by cutting grooves in the die while it is in the lathe, leaving it as shown at *N*, Fig. 1. The steel generally used for steel letter stamping dies is made by Wm. Jessop & Sons.

The letter cutter commences his work by coppering the panels or by heating the blank until it has turned to a dark blue color. The latter method gives a more durable marking surface. Next, with a pencil, he draws on the design or lettering to be cut, taking care to lay out the letters symmetrically

on the blank. The lettering or design must be drawn "reversed," so that the impression that the stamp makes will read right. When the lay-out is finished in pencil, the lines are scratched into the steel with a scriber. This operation is indicated in Fig. 7.

### Countering

The next step is to "counter" the letters. Before going further it may be well to explain what a counter is. In Fig. 9 may be seen the successive steps in making a stamp for the single letter O. At *A* is the stamp with a letter scribed upon the surface. At *E*, is shown the counter for this letter, which is really a punch for forming the inside of the letter. The reason for using counters is that they facilitate the work of shaping the inside of the letter, for it would be a difficult matter, or at least a rather lengthy task, to remove this metal with chisels. After the punch has been driven into the blank, the letter O will appear as shown at *B*, after which the steel is filed away from the outside, which practically completes the letter, as shown at *C*. Fig. 8 shows a steel letter cutter countering the stamp shown being laid out in the preceding illustration, Fig. 7. The letter cutter counters each of the letters on the die in which it would be hard to remove the center of the letter by chipping. This, of course, means that he does not have to counter the letter I or the figure 7, because these and similar characters are easily made by chipping. At *D* in Fig. 9 are shown a few illustrations of figures and counters for letters, figures, etc.

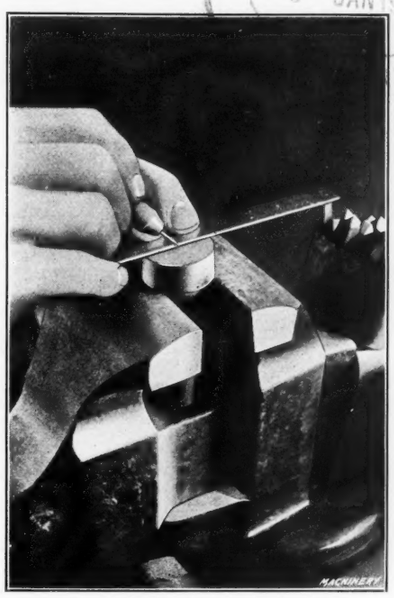


Fig. 7. Laying Out a Stamping Die

Fig. 8. Countering

At *F*, Fig. 9, the effect that countering has upon the steel is shown; at *G* is shown a hand-cut stamp. Under the pressure of the counter, the steel is "mashed" down in the center and spread apart at the sides, slightly rising around the impression as well. It is obvious that this must be detrimental to the steel, but most firms consider that they must employ this method because it is so much quicker than "cutting" the letters complete. It is only fair to state that in making stamping dies at the Noble & Westbrook shop, no counters are used. The steel is removed entirely by cutting, within and without the outlines of the letters. Nine steel letter cutters out of ten use counters in stamp making; therefore, this part of the work is here described.

Fig. 6. Marking Machine

After countering, if countering is employed, the next part of the work is to file away all of the stock possible. This operation is shown in Fig. 10. It should be borne in mind that it is much quicker and surer to remove the steel by filing than by chipping. The proper angle for the filed bevels is 60 degrees.

### Chipping Out the Letters

After all possible surplus steel has been filed away, the metal must be chipped out from between the letters, and, in fact, from every part of the surface that is not required in making the impression. The steel is removed to an approximate depth of 1/64 inch, except on large dies, in which case the cut is deeper. Some of the chisels used are shown in Fig. 13, and it is easy to understand that great care must be taken not to cut out too much stock, nor to cut it out in the wrong places, and there is also constant danger of the back side of the chisel doing damage to the letter with which it may come in contact. At *C* in Fig. 1 may be seen a rolling die that is about one-half chipped out. This will give some idea of the skill that is required to successfully chip out such a die, especially as this rolling die was not countered. The rolling die shown at *B* has been outlined, and is ready for chipping within the design. At *M* is a rolling die that is finished, except for removing the part of the panel that is not required for the lettering. If care is used in the chipping to leave each letter as "clean" as possible, much time will be saved in the subsequent operation of trimming-up the letters. Especially is this true of stamps that are entirely hand-cut, and, moreover, the bevels should be kept as uniform as possible, both within and without the letters, to insure the strength of the letters.

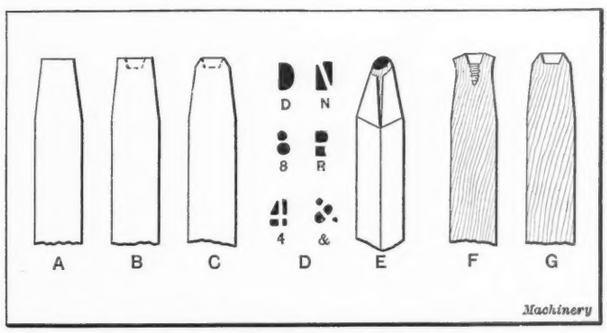



Fig. 9. Making a Stamp with the Aid of Counters

The final operation in the letter cutting, and the most important as well, is the trimming-up of the letters. By this is meant the evening and shaping of the letters from the rough chiseled state. Fig. 11 shows the way in which this part of the work is done. The roll or die is held in a ball vise and the letter cutter steadies the work with his left hand, while he uses the sharp graver with his right hand. At the completion of the work impressions are taken with ink to make sure that the letters are properly shaped, that there are no places under-cut, and that the lines are correct in every detail. In Fig. 13 are shown some of the hand tools used for this operation, and in Fig. 14 the shapes of the cutting points are illustrated. While all of these styles are used, most of the trimming is done either with the "square" or the "sharp" tools, according to the preference of the workman.

Fig. 12 shows another steel letter cutter at work on one of the most difficult pieces of work that it is ever required to produce. It is a rolling die, the face of which is concaved for rolling lettering on a fountain pen, the die being used as shown in Fig. 15 of the article "Fountain Pen Manufacture" in the December, 1911, number of MACHINERY. A concaved rolling die presents unusual difficulties to the steel letter cutter, for he must be very careful not to "lose" the printing surface of the die.

An exceedingly difficult job of steel letter cutting which shows the possibilities of fine work, is illustrated in the stamp shown at *O*, Fig. 1. The face of this stamp is shown enlarged in Fig. 15, the words "Noble & Westbrook, HFD. CT." being cut upon the face, which on this stamp measures but 1/16 inch in diameter. The minuteness of these letters will be appreciated when it is stated that each letter is about 0.010 inch high. The entire surface of the stamp is exactly the same size as an ordinary pin-head. This work was done under the direction of Noble & Westbrook, Hartford, by one of their employes. Such a feat is possible only for a skillful workman, having extraordinarily good eyesight, and then only with the aid of a powerful magnifying eye-glass.

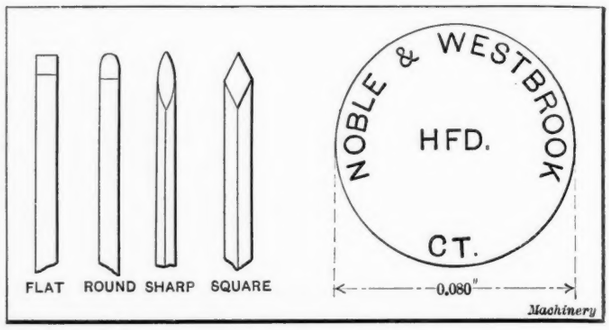



Fig. 14. Various Styles of Gravers used in Letter Cutting. Fig. 15. Enlarged View of Design cut in Raised Letters upon a Stamp Face the Exact Size of a Pin-head

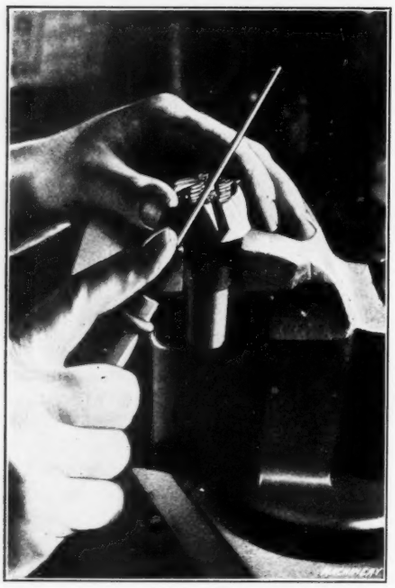


Fig. 10 Filing away the Surplus Steel around the Design

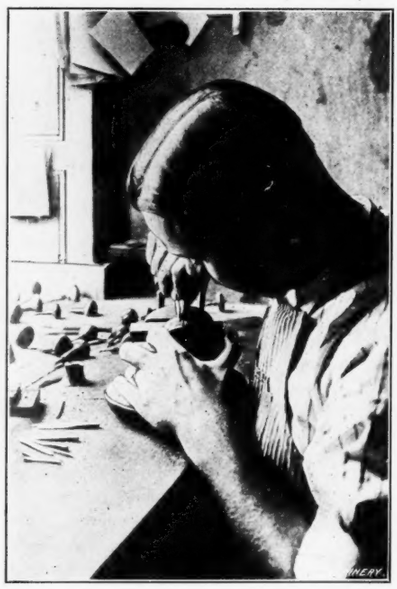


Fig. 11. Trimming up the Letters on a Rolling Die

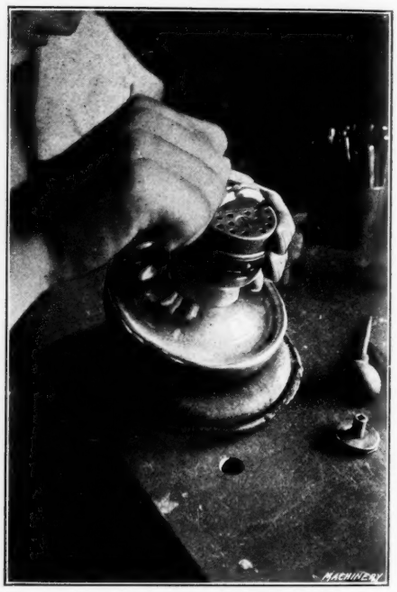


Fig. 12. Showing the Use of an Engraver's Vise in Trimming up Difficult Work

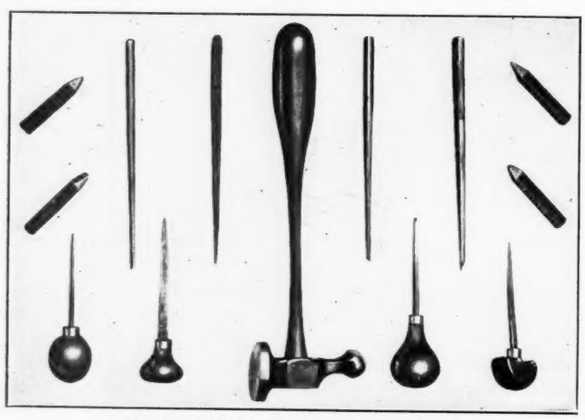


Fig. 13. Chisels, Counters and Hand-tools

### Hardening and Tempering

In hardening a rolling die or a stamping die, it is only necessary to harden the part that includes the lettering. In the case of a rolling die on which the lettering extends around the entire circumference, it is, of course, necessary to harden the die all over. Generally speaking, however, as much as possible of the die should be left soft, in order to lessen the danger of cracking. Steel letter stamping dies are always hardened in brine—never in oil—and the temper is drawn from a faint straw to a very dark straw, according to the metal the die is to work upon.

* * *

As is well known an automobile engine in good condition can often be started "with the spark" when it has not stood idle long. An explosive mixture is retained under compression in a cylinder in the starting position and the spark fires the charge and sets the engine in motion. One of the ingenious automobile accessories brought out in 1911 by the Prest-O-Lite Co. is an engine starter that injects a charge of acetylene gas into the cylinders. The gas forms an explosive mixture with the contained air and when fired with a spark starts the engine. A multiple cylinder pump injects gas into each cylinder using gas from the lighting storage tank. The convenience and simplicity of the device will be generally appreciated. An effective starter eliminates a fruitful source of broken bones caused by engines firing too soon and throwing the crank backward with great force.

# A COMPASS FOR DRAWING CIRCULAR ARCS OF LARGE RADII

By GEORGE W. BURLEY*

By means of the instrument described in the following, the arcs of circles of radii exceeding the capacity of ordinary and beam compasses can be drawn with a fair degree of accuracy. The principle which underlies the working of the instrument is that of the rolling cone or frustum of a cone. The different radii are obtained by varying the distance between the two ends of the frustum and the ratio between their diameters.

The instrument is shown in Fig. 1. It consists essentially of a round metal beam *A*, on which are carried two thin

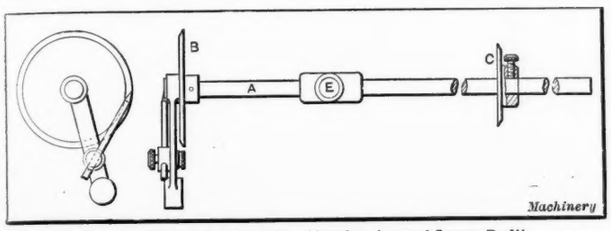



Fig. 1. Device for Drawing Circular Arcs of Large Radii

beveled wheels *B* and *C*, the former being firmly fixed on the beam at one end, while the latter is movable, although it can be fixed in any position on the beam by means of the set-screw shown. A suitable length for the beam is 24 inches; this length can, of course, be either increased or reduced to suit special conditions. On the front face of the large wheel an arm is mounted in such a way that the wheel can rotate without carrying the arm around with it. This arm carries the pencil or pen, the point of which can always be arranged to be on the straight line joining the points of contact between the two wheels and the paper. The distance between the point of the pencil or pen and the point of contact of the large wheel should be as small as possible—in any case not more than one-quarter inch. A handle *E* is provided whereby the instrument is directed in its movements. A weight on the outer end of the pencil arm keeps the pencil or pen-point on the paper.

It will be readily seen that when the instrument is moved at right angles to the axis of the beam, the two wheels,

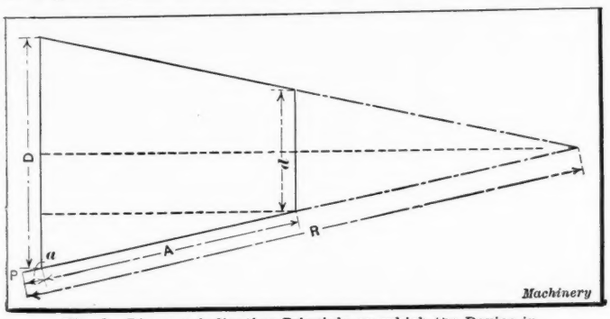



Fig. 2. Diagram indicating Principle on which the Device in Fig. 1 is based

and every part of the beam and the pencil point, will move in circular paths of different radii, but having a common center. These radii depend upon the distance between the two wheels and their diameters. Usually, though not necessarily, the diameter of the large wheel is fixed and never altered, while the diameter of the small wheel is a variable quantity, the range of diameters depending upon the required range of the instrument. By means of this instrument either an arc of a known radius can be drawn, or the radius of a given arc can be determined; of the two the former is the more common case. In this case, before the instrument can be properly set, it is necessary to find the distance between the two wheels. The conditions of the problem are indicated in Fig. 2. The diameter of the large wheel is *D*, and that of the other *d*. The radius required is *R*, and the distance between the wheel edge and the pencil point is *a*, while *A* is the distance required, measured, as will be readily seen, from edge to edge of the wheels and not parallel to the beam; *P* represents the pencil point.

According to the principle of similar triangles:

$$\frac{A}{(D-d)\div 2} = \frac{(R-a)}{D\div 2}$$

Hence,

$$A = \frac{(R-a)\ (D-d)}{D}$$

Let $R = 48$ inches; $D = 5$ inches; $d = 4$ inches; and $a = \frac{1}{4}$ inch. Then,

$$A = \frac{(48-\frac{1}{4})\ (5-4)}{5} = 9.55 \text{ inches.}$$

For radii above 48 inches the value of $a$ may be neglected when it does not exceed ¼ inch.

For each set of values of $D$ and $d$ there is a definite range of radii which can be obtained, the length of the instrument and the maximum value of $A$ being assumed to be constant. To increase this range the value of $d$ is altered, *i. e.*, other wheels are used. This is clearly shown in the following table, which gives the values of the diameters of the smaller wheels necessary for a range of radii from 0 to 640 feet, the diameter of the large wheel being 5 inches and the limiting values of $A$ being 3 and 24 inches. In each case the value of $a$ is neglected.

| Range of Radii, Feet | Diameter of Large Wheel, Inches | Diameter of Small Wheel, Inches | Value of $A$ in Terms of Radius |
|---|---|---|---|
| 0 — 5 | 5 | 3 | $\frac{2}{5} \times R$ |
| 5 — 10 | 5 | 4 | $\frac{1}{5} \times R$ |
| 10 — 80 | 5 | $4\frac{1}{8}$ | $\frac{1}{40} \times R$ |
| 80 — 640 | 5 | $4\frac{63}{64}$ | $\frac{1}{320} \times R$ |

To determine the radius of a given circular arc, it is necessary first of all to set the instrument so that the pencil point will trace the arc. The value of $A$ can then be obtained by measurement, and substituted in the following formula for the determination of $R$:

$$R = \frac{A\ D}{(D-d)} + a$$

To illustrate, let $A = 22$ inches; $D = 5$ inches; $d = 4$ inches; and $a = \frac{1}{8}$ inch. Then,

$$R = \frac{22 \times 5}{(5-4)} + \tfrac{1}{8} = 9 \text{ feet, } 2\tfrac{1}{8} \text{ inches}$$

What has been said will suffice to show the usefulness of the instrument; its cost is not very great.

* * *

## ORIGIN OF STEAM SUPERHEATERS

While superheating in locomotives has only recently been applied in a successful manner, the idea is a very old one. The earliest recorded attempt to use superheated steam in a steam engine is that of Richard Trevethick, an Englishman, who in 1832 used superheated steam in a condensing pumping engine making eight revolutions per minute and having a boiler pressure of 45 pounds per square inch. At this slow speed and under the conditions of operating steam engines in use in those days, the condensation was very great. Trevethick conceived the idea of re-heating the steam in the cylinder to evaporate the condensation; he surrounded the cylinder and piping with firebrick and heated them from a fire on a grate beneath. A remarkable saving was noted, and while 9000 pounds of coal had previously been consumed per day, only 6000 pounds were now required, including the coal used for the superheating grate. This led to further experiments resulting in the Trevethick tubular boiler and superheater, patented in 1832, in which some features that have been retained in modern apparatus were apparent.

* * *

About the worst kind of useless brooding that can be indulged in by a workman is that of imagining that the boss has it in for him. The boss has other things to think about and the man should strive to find other thoughts, too.

* Address: Care of The University of Sheffield, Department of Applied Science, St. George's Square, Sheffield, England.

# THE ROSS RIFLE AND ITS MANUFACTURE—4

## GAGES AND GAGING METHODS*

By DOUGLAS T. HAMILTON†

Interchangeable manufacture on a paying basis is not possible without the use of gages and gaging systems. When few parts are to be made the question of gaging does not enter materially into the problem, but when thousands or perhaps millions of pieces are to be produced and made interchangeable without having to be fitted, it is necessary to provide a complete and accurate system of gaging. The present development of gaging systems is to be credited largely to the manufacturers of firearms, who have fully realized the necessity of absolute interchangeability in their product. While the system which is briefly outlined in the following article pertains more particularly to the production of firearms, it can, with slight modifications, be adapted to other classes of manufacture as well.

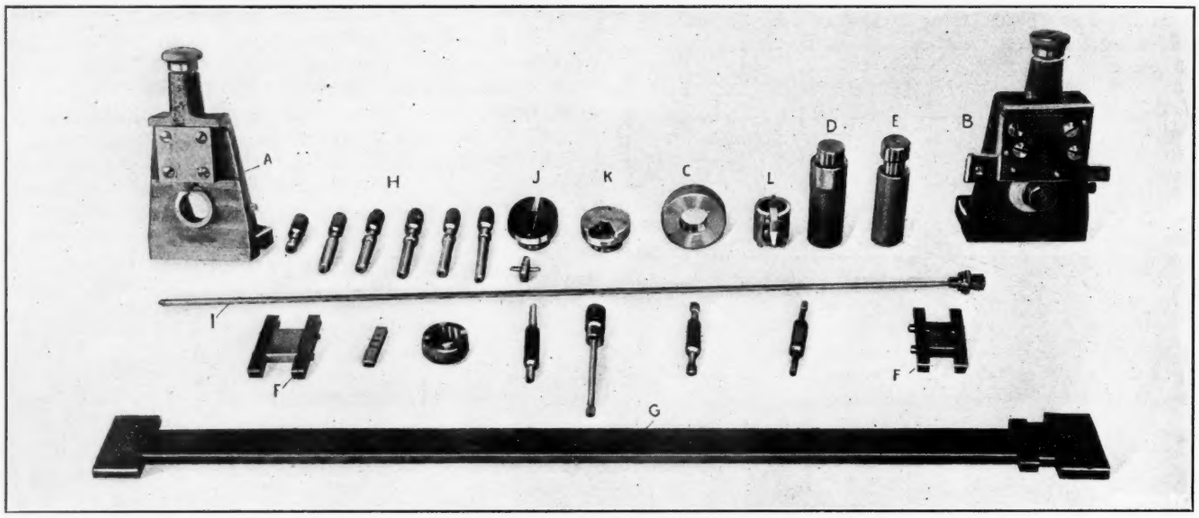



Fig. 48. A Representative Group of Gages used on the Barrel and Receiver

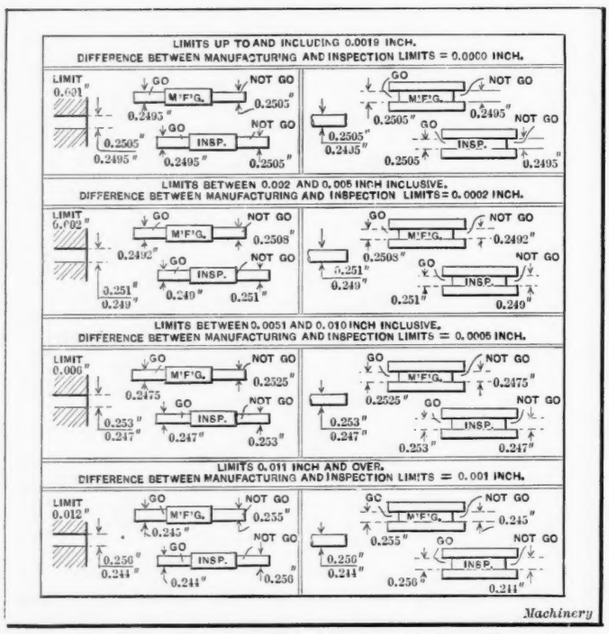



Fig. 49. Diagram showing Method of Figuring Limits on Plug and Snap Gages for Manufacturing, Manufacturing Inspection and Government Inspection Purposes

### Setting Limits on Gages

The limits to be allowed in manufacturing depend entirely on the accuracy required in the product. The greater the accuracy, the closer are the limits that must be employed. Working to close limits brings about a consequent increase in the cost of manufacture owing to the frequent sharpening and resetting of the cutting tools which is necessary. It can therefore be seen that the question of setting limits is very important and should not be decided upon in a haphazard manner.

The limits usually allowed in manufacturing—especially in the production of firearms—vary from 0.0005 up to 0.005 inch for steel parts and from 0.005 up to 0.012 inch for the wooden stock, etc., the limits depending entirely on the requirements of the work. Where two inspection departments are employed—in this case manufacturing and government inspection—it has been found advisable to have the manufacturing and manufacturing inspection gages made within closer limits than the gages furnished to the government inspectors. There are several reasons for this: The manufacturing gages are used more often than the government inspection gages, and are subjected to greater abuse, so that the manufacturing gages wear much more quickly than the other gages. Another reason is that if the parts are made to a gage which is held within closer limits than the gages used by the government inspectors, it is evident that the number of parts returned on account of not coming within the limits will be considerably reduced, which is no small item where a large number of interchangeable parts are to be manufactured. Still another reason which might be given is that the inspection gages act as a detector of wear in the manufacturing gages, and always keep the work within the required limits. The term "inspection gages" used in the following description refers to the gages used by the government inspectors, and not to the manufacturing inspection gages, the latter having the same limits as the manufacturing or working gages.

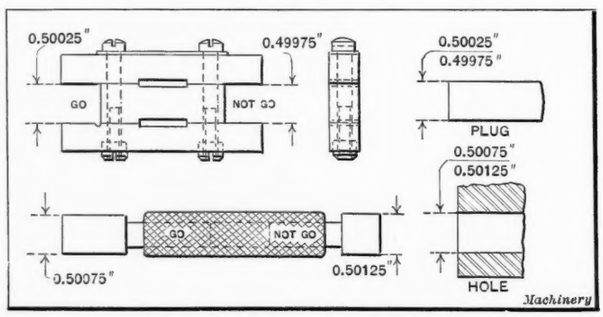



Fig. 50. Typical Plug and Snap Gage used

The strict requirements to be met in the manufacture of rifles for the Canadian government calls for a high degree of efficiency in manufacturing. All of the various parts of the rifle are inspected by government inspectors before they are assembled; and to avoid the possibility of the parts being

* For further information on gages and gage making previously published in MACHINERY, see "A System of Gages for Small Parts," November, 1910, and other articles there referred to; see also MACHINERY'S Reference Book, No. 64, "Gage Making and Lapping."

† Associate Editor of MACHINERY.

rejected by these inspectors, the Ross Rifle Co. has found it advisable to allow a larger limit on the gages furnished to the government inspectors than those used in manufacturing and manufacturing inspection.

To make this difference between the limits used on the manufacturing and inspection gages clear to the gage-maker (gage-making is now a special business), the chart, shown in Fig. 49 was laid out for plug and snap gages. On gages having a limit of not over 0.002 inch, it is not practical to make any measuring difference between the manufacturing and inspection gages. When making the gages, if there is any difference in "feel" between two gages supposed to be the same size, the gage having the smaller limit is sent to the manufacturing department. On gages having limits over 0.002 inch and under 0.006 inch, the manufacturing gages are made 0.0002 inch inside the limits used on the inspection gages. The figures given in the chart, Fig. 49, for plug and snap gages do not refer to gages for parts intended to fit one another. This chart simply shows the difference between the manufac-

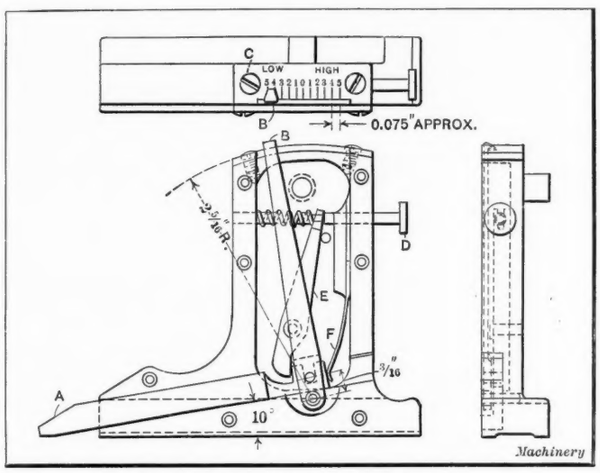



Fig. 51. An Indicating Tool-setting Gage

turing and inspection gages after the original sizes and limits have been established.

### Working to Limit Gages

The limit gages with which the workman is usually provided are of the snap and plug gage variety, as shown in Fig. 50. The snap gages are made with "Go" and "Not go" slots, and the plug gages are made with "Go" and "Not go" plugs. The difference between the diameters of the "Go" and "Not go" slots and plugs is the allowable manufacturing limit on the part.

In making a set of limit gages, the limits are usually given above and below (plus and minus) the mean dimension. To

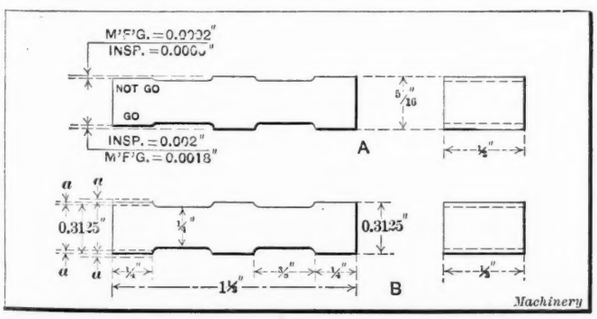



Fig. 52. A Tool-setting Rocker Gage compared with the Ordinary Gage used for Manufacturing and Inspection Purposes

illustrate, say that it is necessary to make a plug or shaft which must fill a hole as shown in Fig. 50, with a fixed maximum and minimum shake or looseness. Suppose that the mean diameter of the hole is 0.500 inch, and that we decide on allowing 0.0005 inch as a limiting difference between the maximum and minimum sizes of the plug and snap gages, giving a maximum freedom of 0.0015 inch between the plug and the hole, or, in other words, a good interchangeable running fit.

Referring to Fig. 50, the "Go" end of the snap gage for the shaft or plug is made 0.50025 inch and the "Not go" end, 0.49975 inch. The "Go" end of the plug gage for the hole is made 0.50075 inch, and the "Not go" end 0.50125 inch. The greatest shake, therefore, would be the difference between the largest hole and the smallest shaft or plug, which equals $0.50125 - 0.49975 = 0.0015$ inch; and the least shake is the difference between the largest shaft or plug and the smallest hole, which is $0.50075 - 0.50025 = 0.0005$ inch.

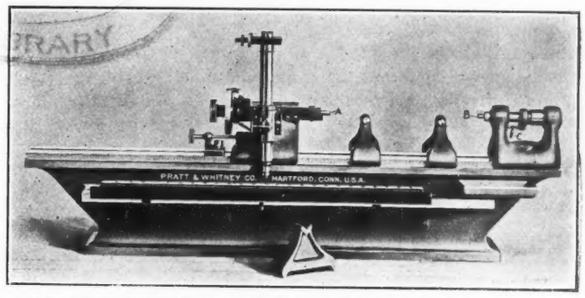
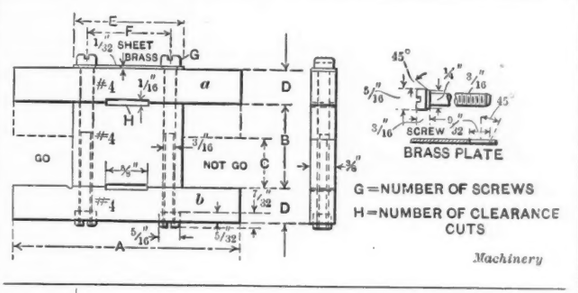



Fig. 53. Pratt & Whitney Measuring Machine, which is used as a Standard Reference for Gages

Work gaged by gages which are made in this manner will always go together; but the natural tendency of the operator, to avoid spoiled work, is to work as close as possible to the "Go" end of the gage. This means that a large majority of the parts will go together with the minimum allowable freedom, or 0.0005 inch, when the ideal freedom is the mean or 0.001 inch.

This tendency of the operators to always work to the "Go" end of the gage, has brought about the adoption of a tool-setting gage. This tool-setting gage is made to the mean di-

DIMENSIONS OF STANDARD PARTS FOR SNAP GAGES




| No. of Gage | Dimensions in Inches | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | A | B | C | D | E | F | G | H |
| 1 | $2\frac{1}{16}$ | $\frac{1}{4}$ | 0.00 | $\frac{1}{4}$ | $1\frac{3}{8}$ | $1\frac{1}{4}$ | 2 | 1 |
| 2 | $2\frac{3}{8}$ | $\frac{1}{2}$ | $\frac{1}{4}$ | $\frac{5}{16}$ | $1\frac{3}{8}$ | $1\frac{1}{4}$ | 2 | 1 |
| 3 | $2\frac{5}{8}$ | $\frac{3}{4}$ | $\frac{1}{2}$ | $\frac{3}{8}$ | $1\frac{3}{8}$ | $1\frac{1}{4}$ | 2 | 1 |
| 4 | $3\frac{3}{8}$ | $1\frac{1}{4}$ | $\frac{3}{4}$ | $\frac{1}{2}$ | $1\frac{3}{8}$ | $1\frac{1}{4}$ | 2 | 1 |
| 5 | 5 | 2 | $1\frac{1}{4}$ | $\frac{5}{8}$ | $2\frac{1}{2}$ | $1\frac{1}{16}$ | 3 | 2 |

mension, and shows the operator what is desired for the part he is making. As soon as the operator becomes familiar with the tool-setting rocker, or gage, he finds it a great help, as it avoids frequently adjusting the machine. If the cutter wears or the machine springs, so that the part is not cut to the mean dimension after the machine has been set, there is still a sufficient marginal limit between the extremes (maximum and minimum) so that the working gages will not reject the work.

By the old method (working to the limit gages exclusively), the least variation in the work from the "Go" end of the gage, caused the operator to recut the work—a waste of time—or if the "Go" end went over the work easily, he was afraid that the next piece would go in the "Not go" end and be spoiled; hence he attempted to adjust his machine. This waste of time increased the cost of the parts considerably, and also tended to confuse the operator and make him inefficient.

### Tool-setting Gages

To hold the work as close as possible to the mean dimensions—the ideal aimed at in interchangeable manufacture—the Ross Rifle Co. has adopted what is called a tool-setting gage. The first gage designed to perform this function is shown in Fig. 51. This gage, as can be inferred, is expensive to make, and as a large number of tool-setting gages are necessary, it was discarded in favor of a simpler and cheaper gage. As it might be possible, however, to use a gage of this type for other work, a short description of it is included.

The gage shown in Fig. 51 is designed on the multiplying lever principle, combined with an angularly operating finger, and multiplies an error about seventy-five times; that is, a difference of 0.001 inch in the distance from the lower face of the measuring finger *A* to the base of the gage equals a movement of approximately 0.075 inch of the pointer *B* on the scale *C*. The movement of the pointer *B* corresponding to a difference of 0.001 inch on the finger *A* equals $2\,5/16 \times 3/16 \times \sin 10 \text{ deg.} = 2.3125 \times 0.1875 \times 0.17365 = 0.0753$ inch. As the spaces between the graduations on the scale are not uniform in gages of this type, they are usually marked off after the gage is assembled; this is accomplished by using "feelers" or thickness standards for each thousandth of an inch movement of the indicating finger. This gage is operated by pushing in the spring plunger *D*, which, through the lever *E* pivoted to the frame, draws back the finger *A* against the tension of the flat spring *F*. The finger *A* is slotted and fits a pin driven into the pointer *B*, pivoted in the base of the gage, this action moving the pointer along the scale *C*.

A gage which is used extensively in the manufacturing of the parts for the Ross rifle, and especially on those parts which are milled and profiled, is the "block" and "rocker" gage. This consists of a stand for holding the work, with a hardened and ground block fastened to its top face, and a small block called a "rocker" as shown in Figs. 52 and 59. The rocker *A*, Fig. 52, is provided with three bosses on each side, the bosses on one end being ground lower than the other two an amount equal to the limit allowed. Three of these rocker gages are made, two for manufacturing and the other for government inspection purposes.

The same trouble is encountered in the use of the rocker gage as with the limit plug and snap gages, that is, the operator always works as close as possible to the "Go" boss. To obviate this, a tool-setting rocker gage, as shown at *B* in Fig. 52, was made. This block is ground so that the operator sets the cutter to the mean size instead of above or below the mean, as would be the case if the ordinary rocker gage shown at *A* were used. Limits are not allowed on this tool-setting gage, the object of which is to show the mean size of the gages. A slight allowance, however, is sometimes made to provide for wear on the cutter, thus obviating the too frequent sharpening and resetting of the cutter. The position of the limits *a* above or below the mean surface of the rocker depends on the character of the operation and the cutter used.

In making gages, it is absolutely necessary to have some standard of measurement. The Ross Rifle Co. uses a Pratt & Whitney micrometer measuring machine, as shown in Fig. 53, as the standard of measurement, and all gages are tested for accuracy in this machine. The machine is first set with a master gage which is held between the jaws *A* and *B*. Then it is adjusted so that the small plug *C*, when touched, will swing back and forth between the two auxiliary jaws without dropping out. By taking the reading on the micrometer dial and then putting the gage to be measured between the jaws *A* and *B* in place of the master, it can readily be seen whether the conditions of pressure upon the gage to be measured are the same, by noting the action of feeler gage *C*. Any variations between the standard gage and the gage being measured may then be read off by means of the subdivisions on the divided index circle. By means of this instrument it is possible to duplicate sizes of working gages from a standard to within 0.000025 inch.

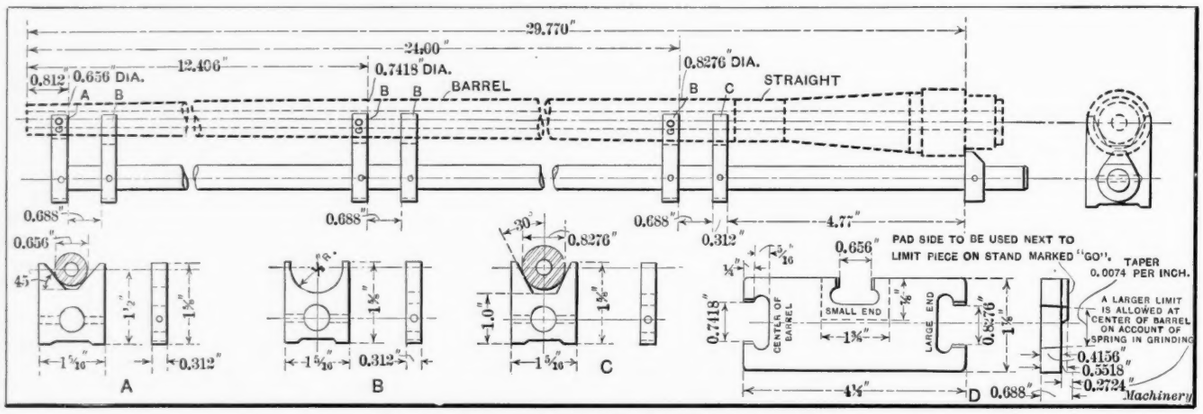



Fig. 54. Gages used in Gaging the Taper on the Barrel

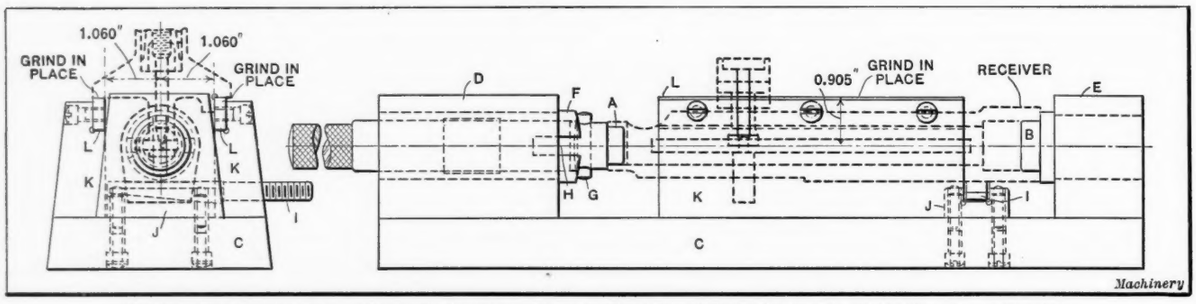



Fig. 55. Stand used in Connection with the Gages shown in Figs. 57 and 58 for Gaging the Guide Slots in the Receiver

### Standardizing Snap Gages

The ordinary solid snap gage has been found unsatisfactory for accurate work, mainly on account of its short life. As soon as this gage wears to any appreciable extent, it has to be discarded. This unsatisfactory feature has brought about a design of gages, the wearing points of which can be duplicated at small cost. A standard snap gage of this kind is shown in connection with the accompanying table. This gage is made in five sizes, numbered 1 to 5. The spacing blocks are made from machine steel, varying in thickness by 1/32 inch, that is, the space between the maximum and minimum sizes *B* and *C* for each number of gage is divided into thirty-seconds of an inch. For example, eight spacing blocks

would be made for gage No. 2. These spacing blocks are case-hardened and ground and have the size stamped in the clearance cut. The top block *a* is ground perfectly parallel, while the bottom block *b* is made with the limit allowed, and is stamped accordingly. Both of these blocks are made from tool steel and hardened.

When a snap gage of a certain size is desired, the two blocks *a* and *b* and a spacer of the required thickness are obtained from the store-room and fastened together by screws, which are also standardized. A brass name-plate which carries the piece and operation numbers is put on, thus obviating the stamping of the gage proper, and when worn the gage can

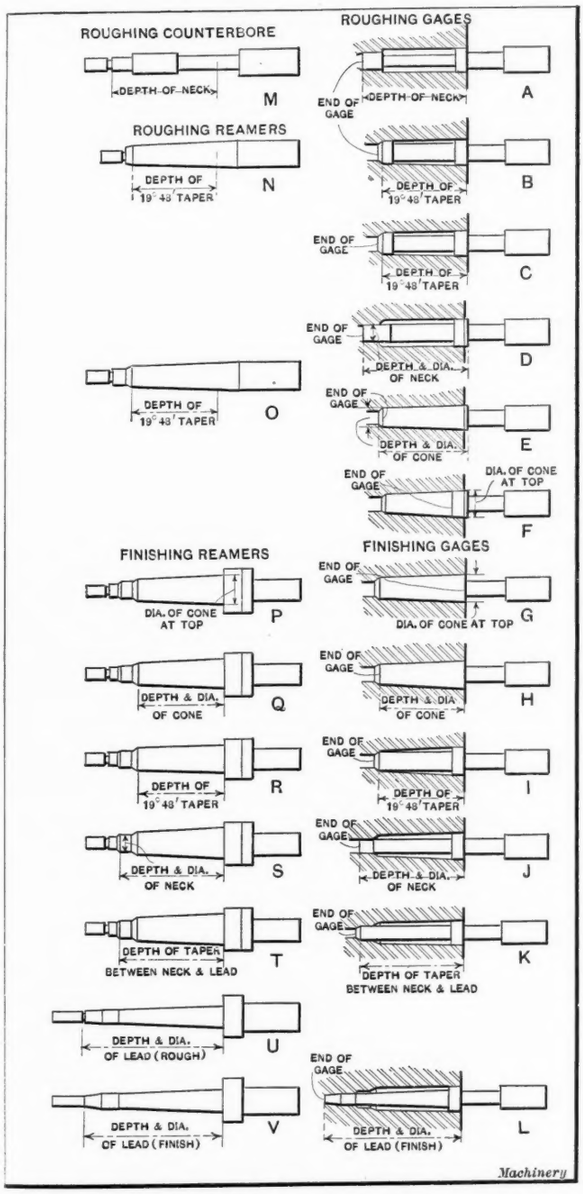



Fig. 56. Diagram illustrating the use of the Tools for Machining and the Gages for Gaging the Chamber in the Barrel

be taken apart, ground, put together and used indefinitely. The advantages of this type of snap gage for interchangeable manufacture are obvious.

### Gaging the Taper on the Barrel

After the barrel has been finish-ground externally in the Brown & Sharpe plain grinder, the taper, which is 0.0074 inch per inch, is inspected in the gage shown in Fig. 54. The barrel is held in the supports *A*, *B* and *C*, which act as a stand, and also as limit "points", snap gage *D* working in between them. The limit blocks are all placed the same distance apart—0.688 inch—and as a greater limit is necessary at the center of the barrel on account of spring in grinding, that part of the gage for the muzzle end is padded on one side to reduce the limit. The limit allowed at the muzzle end is 0.001 inch, the padded side of the gage being held against the "Go" block *A*. The limit allowed in the center and large end of the barrel is 0.002 inch; the gage *D* for these parts not being padded, has a greater movement between the limit blocks. The barrel is gaged at the muzzle and near the

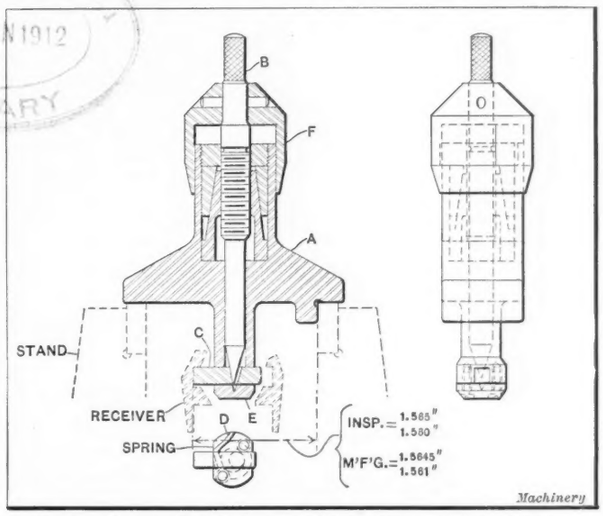



Fig. 57. Gage used in Gaging the Distance from the Center Line to Sides of the Guide Slots in the Receiver

breech end at the points where the front and rear sight bases are located, so that the sight bases will be in the same relative positions on each barrel. The gage shown at *G*, Fig. 48, is used for gaging the over-all length of the barrel, while the gages used for the extractor and entrance cuts in the breech end of the barrel are shown at *J*, *K* and *L*.

### Gaging the Chamber in the Barrel

One of the greatest difficulties which confronted the pioneer rifle manufacturer was the finishing of the chamber for the cartridge so that the bullet would always be held concentrically and started properly. Since the adoption of the solid-drawn cartridge case in 1885, great strides have been made in designing and making the cartridge chamber. The increasing demand for accuracy in the modern rifle necessitates the production of a chamber concentric with the bore, so that the bullet will leave the rifling grooves with the least possible distortion and without any change in its concentricity and gyroscopic stability.

It is not an easy problem to produce a perfectly chambered rifle, and it requires both a high degree of workmanship and

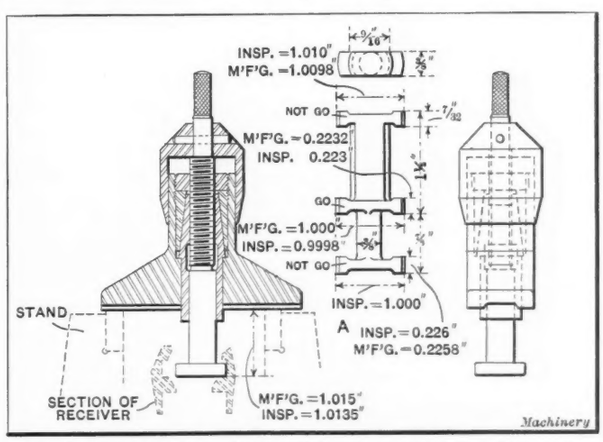



Fig. 58. Gage used in Gaging the Distance from the Center Line to the Bottom of the Guide Slots in the Receiver

a complete and practical gaging system for its accomplishment. The chart shown in Fig. 56 illustrates the counterbores, roughing and finishing reamers, and also the roughing and finishing gages used for machining and gaging the chamber in the 0.303 Ross military rifle. Those not familiar with this problem will, no doubt, think that a number of gages and reamers shown on this chart are superfluous. This is not

the case, however, as will readily be seen by a close inspection of the chart.

The chamber is first roughed out with the counterbore *M*, and then gaged at the mouth and in the bore with the gage *A* to see that the counterbored hole is of the exact diameter and is concentric with the bore in the barrel. Then the chamber is reamed with a roughing reamer *N* and gaged with the gage *B*. The reamer shown at *O* is then used for finish-reaming the taper and neck and also for roughing the cone diameter. Now it would be impossible to make one gage so that it would act as a detector for all the various diameters finished by this reamer, this inspection requiring the use of the gages *C*, *D*, *E* and *F*, the lines on which should come flush with the end of the barrel when the reamer is of the correct size and is put in to the proper depth.

This finishes the rough-reaming and gaging operations, after which every part of the chamber is again finished with finishing reamers and gaged. The operations accomplished by the reamers *P* to *T*, inclusive, are inspected with the gages *G* to *K*, the latter also appearing at *H*, in Fig. 48. These gages are made so that a very slight change in diameter could easily be noticed by shaking the gages.

The reamers *U* and *V* and the gage *L* are used for machining and gaging the lead. The lead may be briefly defined as "the conical funnel which leads from the chamber to the bore". If the chamber were to end abruptly at the beginning of the bore in the barrel, the sharp ends of the lands would cut strips out of the nickel-jacketed case of the bullet and the latter would fly to pieces when it left the muzzle of the rifle. The lead must be perfectly concentric with the chamber and bore or else the bullet is likely to wobble or tumble after it leaves the muzzle.

The bullet is usually made equal to the nominal diameter of the bore plus the depth of one rifling groove, but it is sometimes made equal in diameter to the nominal bore plus one and one-half times the depth of one groove. The result of this is that the lands form corresponding grooves in the case of the bullet, the latter expanding and filling the rifling grooves when the cartridge is discharged. The function of the lead, therefore, is to allow the bullet to gradually take the lands of the rifling. The gage used in testing the diameter of the rifling grooves is shown at *I* in Fig. 48.

No doubt the exceptional accuracy of the Ross rifle is largely due to the care taken in finishing the chamber, making it perfectly concentric with the bore in the barrel. The method of gaging shown by the chart Fig. 56, being peculiar to rifle manufacture, illustrates, probably better than anything else would, the extreme accuracy which is necessary in this class of work.

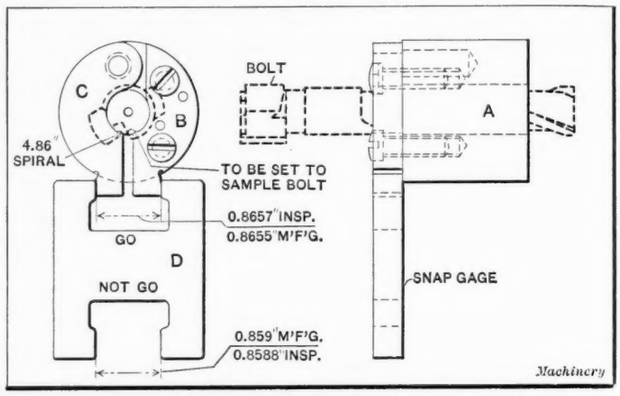



Fig. 61. Snap and Swinging Gage used in Gaging the Width of the Spiral Ribs on the Bolt

### Gaging the Receiver

To gage the guide slots for the bolt sleeve in the receiver, the latter is placed on plugs closely fitting the reamed holes in each end, as shown in Fig. 55. These plugs *A* and *B* are held in a cast-iron stand *C*, provided with bosses *D* and *E* on each end. The plug *B* is driven into a reamed hole in the boss *E*, while the plug *A* is held in a hardened and ground sleeve *F*, forced into the boss *D*. The front end of the sleeve *F* is provided with a cam face against which the pin *G*, driven into the plug *A*, works. When the receiver is placed on the plugs, the plug *A* is turned by gripping the knurled end, and when this plug is turned, the pin *G*, working against the cam face on the bushing, forces the plug out, thus holding the receiver rigidly between the shoulders on the two plugs. A slot *H*, cut in the bushing *F*, which is a loose fit for the pin *G*, allows the plug *A* to be withdrawn to remove the receiver.

The receiver is prevented from rotating on the plugs, and the guide slots in it are held parallel with the hardened and ground measuring blocks *L* by means of a tapered wedge *I*. This wedge fits in a beveled slot in the block *J* which is fastened to the base by fillister-head screws. The slot is cut at an angle of 5 degrees with the measuring blocks *L*, so that the top face of the wedge is parallel with them. Shallow grooves are filed in the handle of the wedge *I* to facilitate its removal. The central portion of the stand is provided with two bosses *K* to which are attached hardened and ground blocks *L*. These blocks *L* act as a measuring surface for the micrometer gage shown in Fig. 57, which is used for gaging the distance from the center line of the receiver to the sides of the bolt sleeve guide slots. The gage is shown (dotted) in position for gaging one side of the guide slot in Fig. 55. The other side of the guide slot is measured by simply reversing the position of the gage.

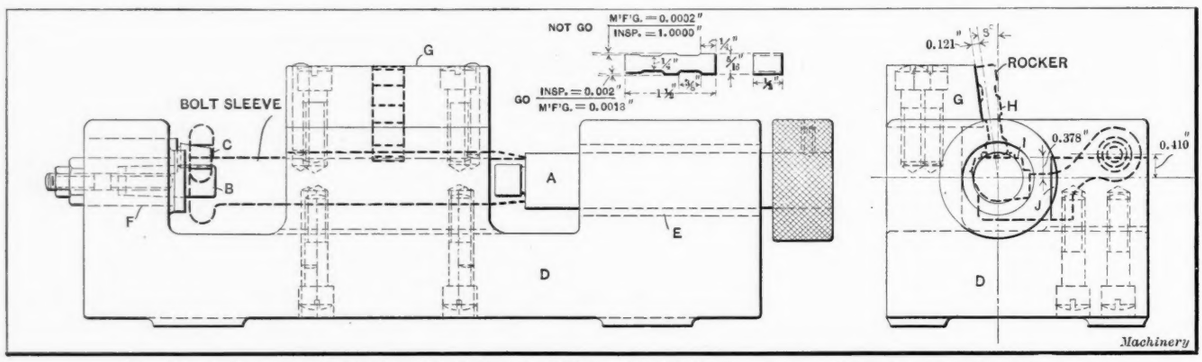



Fig. 59. Rocker Gage and Stand used in Gaging the Position of the Milled Groove in the Under Side of the Bolt Sleeve

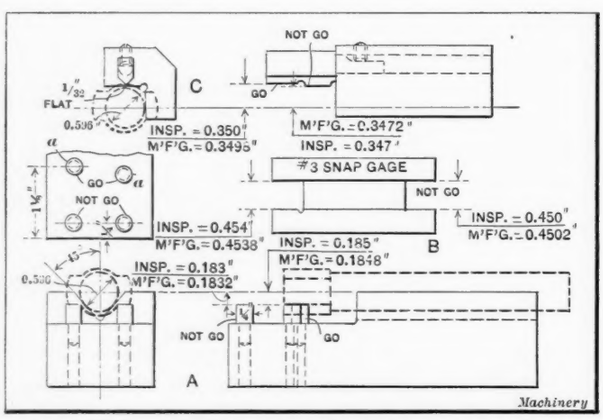



Fig. 60. Snap and Stand Gages used in Gaging the Head of the Bolt after Form Milling

Referring to Fig. 57, it will be seen that the gage consists of a base *A*, provided with a lug which fits against the hardened and ground measuring blocks on the stand, Fig. 55. A cone-pointed and threaded spindle *B* extending downward through the center of the body of the gage actuates by its cone-pointed end a measuring finger *C*. This finger *C* is retained by means of a flat spring *D* (shown in the lower view) which fits in a slot in the finger and also in the base of the gage. A cap *E* is fastened to the stem of the gage by two screws, as shown, to prevent the finger *C* from dropping out. The spindle *B* is provided with forty threads per inch and is pinned to a thimble *F*. The graduations on this thimble are laid out after the gage has been assembled and set by means of a master. Two gages of this type are made, one for inspection and the other for manufacturing purposes. As can be seen, these gages are provided with the ordinary split nut for adjusting purposes.

In Fig. 58 is shown the gage which is used for gaging the distance from the center of the receiver to the bottom of the

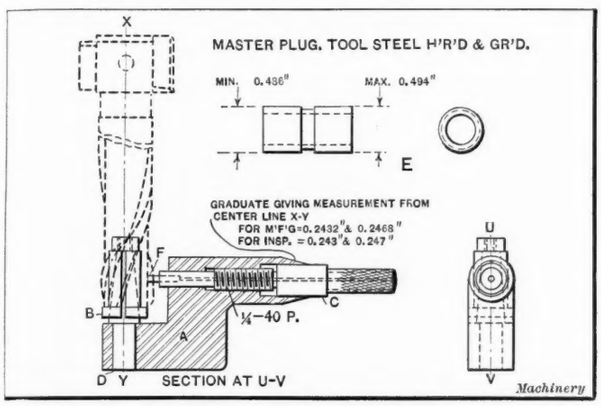



Fig. 62. Micrometer Gage for Gaging the Diameter of the Bolt at the "Root" of the Spiral Ribs

bolt sleeve guide slots. A stand of the type shown in Fig. 55 is used for holding the receiver, and the measurement is taken from the hardened and ground blocks. The gage is practically of the same construction as that shown in Fig. 57, except that the spindle is provided with a head which acts as a measuring point. Two of these gages also are used, one of which is marked with the manufacturing limits and the other with the inspection limits. After the position of the guide slots in the receiver, relative to the center line, have been determined with the gages shown in Figs. 57 and 58, the limit gage, shown at *A* in Fig. 58, is used to determine

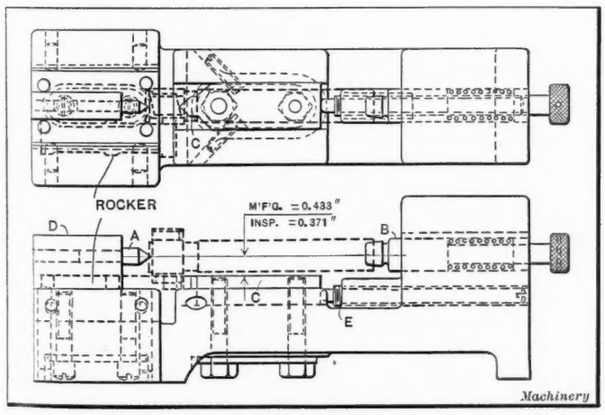



Fig. 63. Stand and Rocker used in Gaging the Locking Cam at the Rear of the Bolt Head

the width of and the distance between the guide slots. The use of this gage is clearly indicated in the illustration.

The receiver has a score mark placed on it which lines up with a corresponding mark stamped on the breech end of the barrel. These marks are produced by the marking gages shown at *A* and *B* in Fig. 48. Gage *A* produces the score mark on the barrel, while gage *B* puts the mark on the receiver. These gages consist essentially of a spring-actuated plunger which is sharpened on its lower end and is depressed by hitting the knurled knob with the hand. The receiver is screwed onto a threaded plug, while the barrel is held in a threaded bushing. The gage for testing the thread on the barrel is shown at *C* and those for testing the position of the score mark and the thread in the receiver are shown at *D* and *E*. Two standard built-up snap gages are shown at *F*.

### Gaging the Bolt Sleeve

A good example of the application of the rocker gage is shown in Fig. 59. Here the position of the milled groove in

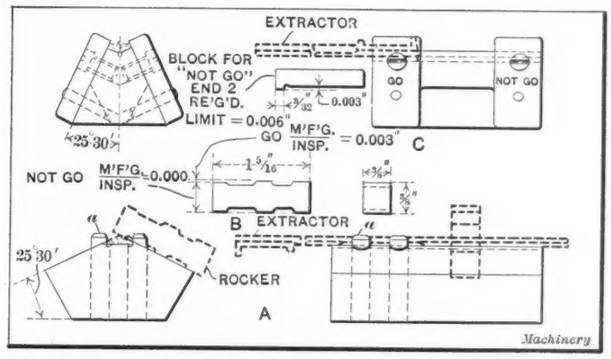



Fig. 64. Gages used in Gaging the Thickness and Width of the Extractor

the under side of the bolt sleeve is located. The bolt sleeve is placed on the hardened and ground plugs *A*, *B* and *C* which are held in the cast-iron base *D*. The plug *A* is provided with a knurled head and is made a good fit in the hardened and ground sleeve *E*. Plug *B* is made with a tapered shank, and is held in a corresponding hardened and ground tapered sleeve by a stud and nut as shown. The sleeve *F* is provided with a shoulder which butts against the cast-iron boss on the base *D*. The plug *C* is tapered and fits the hole in the handle of the bolt sleeve and is driven into a reamed hole in the boss on the casting.

A hardened and ground block *G*, fastened by screws and dowels to the casting *D*, acts as a measuring surface for the rocker gage *H*, which is applied in the manner shown in the illustration. This rocker is hardened and ground and the bosses on one end are lower than the other two bosses on each

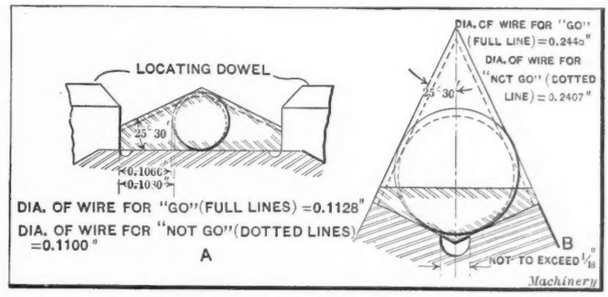

LOCATING DOWEL
25° 30'
DIA. OF WIRE FOR "GO" (FULL LINE) =0.2450"
DIA. OF WIRE FOR "NOT GO" (DOTTED LINE) = 0.2407"
DIA. OF WIRE FOR "GO"(FULL LINES) =0.1128"
DIA. OF WIRE FOR "NOT GO"(DOTTED LINES) =0.1100"
A
B
NOT TO EXCEED 1/16"
Machinery

Fig. 65. Diagram illustrating the "Wire Method" used in Measuring the Gages shown in Fig. 64

side an amount equal to the limit allowed. This stand *D* is also used for gaging the height of the shoulder *I* on the bolt sleeve, the rocker *H* being placed on the hardened and ground block *J* in a similar manner.

### Gaging the Bolt

After the head of the bolt is form-milled, it is gaged in the gages shown in Fig. 60. The gage shown at *A* locates the position of the faces of the lugs by means of pins driven into the V-block in which the bolt is placed. A point worthy of attention in this gage is the staggered position of the ¼-inch pins *a*, shown in the plan view. Locating the pins in this manner facilitates the inspection of the work. The thickness of the lugs is tested by means of the standard snap gage shown at *B*, and the height of the shoulder on the bolt head is gaged in the gage shown at *C*. This latter gage consists of a plain block in which the limit gage, provided with "Go" and "Not go" bosses is held by a screw.

An interesting gage for taking a difficult measurement is shown in Fig. 61. This gage is used for inspecting the width of the spiral ribs on the bolt. It consists of a block *A*, to

which is held a rigid jaw *B* and a swinging jaw *C*. The limit snap gage *D*, which is used to take the measurement, fits over the ground ends of the jaws *B* and *C*. That part of the jaws which comes in contact with the spiral ribs on the bolt is cut to fit the spiral rib, which makes one turn in 4.86 inches.

The diameter of the bolt at the root of the spiral ribs is measured by means of the gage shown in Fig. 62. This consists of a frame *A*, holding a split sleeve *B*, and a micrometer spindle *C*. The sleeve *B* is held on a conical plug *D* by a nut, and is split so that it can be made to fit snugly in the hole in the bolt. To lay off the limit lines on the gage, the master plug *E* is placed on the sleeve *B* and the measuring point *F* is brought in contact with it.

Another interesting use of the rocker gage is shown in Fig. 63. This gage is used to gage the position of the locking cam on the rear of the bolt head. The bolt is placed on the center *A* and the spring-actuated plug *B*, and is rotated until the cam comes in contact with the 90-degree pointed block *C*. The rocker is then used from the sides of the block *D*, holding the center *A*. The pointed block *C* is adjusted by means of the screw *E* and is set to a master bolt. The block holding the center *A* is also made adjustable and is set in the desired position.

### Gaging the Extractor

The extractor, which is used for removing the exploded cartridge from the chamber in the barrel, is beveled on the back and fits in a groove cut in the bolt sleeve. The thickness of this extractor and the angles of inclination of its back are gaged in the block and rocker gage shown at *A* in Fig. 64. The extractor is located between four pins *a*, and the rocker shown at *B* is applied as illustrated. The tapered sides and width of the extractor are gaged in the block gage shown at *C*. This gage, instead of having a rocker, consists of a plain block beveled to the required shape and to which four blocks are fastened, two on each end. The blocks on one end are ground so that a perfect extractor will not enter, while the blocks on the other end are ground so that a perfect extractor will enter. To facilitate the making of these gages, the drafting department laid out two diagrams as indicated in Fig. 65, in which the angular faces of the gages were determined by means of the "wire method," with which most toolmakers are familiar.

### Conclusion

No better proof of the accurate work necessary in producing a high-grade military rifle could be given than a description of the methods used in gaging the parts. While all the important gages used in the production of the Ross rifle are not described in the foregoing, the principal ones are included. The gaging of the chamber in the barrel is an excellent example of the care taken in making the chamber in each barrel an exact duplicate—a commendable feature in any rifle. The writer wishes to express his gratitude, at this point, for the assistance given him by the various men connected with this company who are in charge of the production and engineering departments.

* * *

An interesting commercial application of cerium alloys has recently been made. These alloys possess the property of emitting sparks when struck, and this property has been made use of in the shape of a match box. The alloy used is of cerium and iron, and the spark is produced by a rubbing contact with a steel file wheel, the spark igniting a wick saturated with gasoline which is contained in the interior of the case. The application is unique as it employs a metal which heretofore has had no commercial use. The same idea has also been used in a device for lighting gas, consisting of a holder with a cerium iron alloy which rubs on a steel file and emits a sufficient spark to ignite gas.

* * *

## EDISON'S LATHES

According to the *English Mail* of August 17, "Edison's sleeping couch is a wooden bench which is placed just where a workman at a certain hour must come for a lathe or a lever."

There is nothing like system—unless perhaps a pocket turret lathe. R. G.

## WHY THE SHOP DOES NOT RETAIN THE SKILLED MECHANIC

### OBSERVATIONS BY "ONE WHO HAS BEEN THROUGH THE MILL"

By EX-TOOLMAKER

Every once in awhile we read articles relating to the expert mechanic of the future—where he is to come from, and how he is to be trained along mechanical lines to the best advantage. Anyone who is at all familiar with modern shop practice will admit that the expert all-around machinist and toolmaker, who could construct any complicated piece of machinery from drawings alone, are not to be found as readily as they were fifteen years ago, when ten hours constituted a day's labor, and three dollars for ten hours' work was considered good wages. In the last fifteen years wages have increased about twenty-five per cent; this increase has been necessary to keep pace with the present cost of living. The hours of labor in many sections of the country have been reduced from ten to nine, and the machinist and toolmaker often work under better conditions in modern, well-ventilated and sanitary shops. Why it is, then, that good mechanics are so hard to find?

There are several reasons for this. In the first place very few shops have anything like an effective system for training apprentices. To hire a boy for small wages and put him on routine work under the supervision of a straw boss may be an excellent method for cutting down the cost of production, but it is certainly a poor way to try to make an expert mechanic. No matter how much mechanical intuition a young man inherits, he never can become a good mechanic without practice and a varied experience. To become an expert machinist or toolmaker under present-day conditions is no small undertaking. To begin with, a young man should—to a marked degree—possess mechanical intuition, or the ability to see through mechanical problems readily. After working for say three years in one shop he should travel and work in different shops to become better familiar with different methods of modern shop practice. It is a generally acknowledged fact that the mechanic who has had only a limited experience in one or two shops is seriously handicapped by his lack of knowledge concerning different methods of handling and getting out work. To be sure, he can go ahead and do as the foreman tells him, but no foreman places much confidence in the man who cannot go ahead and do a little independent thinking for himself.

However, after a young man has traveled for a few years, working on everything from sewing machines to battleships, he has gained a considerable knowledge of different methods of handling work, and he cannot be blamed if a possible twenty-five cents per day more than the average stay-at-home mechanic receives does not seem attractive enough for a steady diet. His traveling has taught him self-confidence and self-reliance. Therefore, he generally finds something more attractive than a possible forty cents per hour, with his time rung up on a time clock. And this is no idle dream, either. Let anyone who doubts it take a trip through the Middle West, where salesmen are plentiful, and note the number of expert machinists who are selling everything from high-speed steel to complete machine shop outfits.

An ever-increasing army of expert machinists is employed in this manner, and they certainly cannot be blamed for giving up the shop for a traveling position with a good house. If a man has the courage and persistency to put up with the hardships that are a necessary part of the roving machinist's life, he generally has brains enough to plan out some way for getting paid for what he knows by representing, in one way or another, some reliable concern dealing in machinery or shop accessories.

The chief trouble in the shop is that everything is against the individual man; he plays a losing game from start to finish. If, while on his way to work, he is delayed by a car being stalled, or a drawbridge being open, or by some other cause beyond his control, he is the loser of a few minutes

which mean just so much money to him. If the whole shop's crew form the opinion that they deserve an increase in wages and go to the manager in a body, they generally are told that they can only be dealt with as individuals. If, on the other hand, one man asks for an increase in wages, he is told that he is receiving the maximum rate paid to mechanics of his kind, and that the shop does not pay above a certain limit. If he happens to be working on piece-work and originates methods for cutting down the cost of production, does he get more pay for getting out more work? Well, not so that you would notice it; his rate is cut instead. This certainly does not look like the proper way of encouraging ambition; however, it is part of the present system.

Expert machinists and toolmakers are a highly intelligent class of men, and to tie them to a time clock along with men who often cannot read or write is wrong from the start. It is not to be wondered at that they take the first opportunity to go to work at something that has at least the semblance of a Mr. before it. The greatest trouble is that the average manufacturer does not seem to make any distinction between the skilled and the unskilled labor in his employ. It takes a number of years for a man to become a skilled mechanic, and the average manufacturer is making a serious mistake in ignoring this fact and treating skilled and unskilled labor alike.

Expert machinists and toolmakers of recognized ability should be hired by the year and not by the hour. This would do more toward solving the problem of retaining expert help than any other means, as it would, in the first place, give the mechanic confidence in his employer, where distrust now exists. This would result in a large increase of the amount of work turned out; as it stands now, confidence does not exist, which often means curtailment of production.

The average manufacturer has put his office help on the honor system because he had to. Does the pretty little typewriter stand for being docked if she is a few minutes late? Certainly not, nor does the cub draftsman, for that matter. It certainly takes more skill to become an expert machinist or toolmaker than it does to become a stenographer or draftsman. Why then not put the expert machinist and toolmaker on the honor system also? They certainly are employes that cannot be dispensed with. These conditions probably will not come about in the near future, but they may in time. In the meanwhile the smoking section of a Pullman and a good hotel seems to satisfy a small army of expert mechanics who never would have left the shop if conditions had been somewhere near what they should be.

* * *

## ITALIAN STEAM TURBINE LOCOMOTIVE

In the August, 1910, number of MACHINERY, railway edition, a turbine locomotive built by the North British Locomotive Co., Ltd., of Glasgow, was described. According to the *American Engineer and Railroad Journal*, a small locomotive fitted with specially designed turbines has recently been successfully tried at Milan. The peculiar feature of the turbine is the use of movable blades, which are operated in series. Four sets of blades are used. At high speed, the steam strikes the first set of blades only, while at intermediate speeds, two or three sets come into play. The reversing mechanism is a rather unique feature. The rotors have two sets of blades of opposite curvature. When running in one direction, the steam passes over the blades from left to right; when running in the opposite direction, the steam passes over the other set of blades from right to left. It is reported that the engine starts well under load, both on curves and grades, and that the steam consumption has not exceeded 38 pounds per horsepower-hour, when running in either direction.

* * *

Unofficial reports of the large Hamburg-American liner, originally called the *Europa*, but now named the *Imperator*, state that the vessel will be approximately 900 feet in length with a width of 96 feet and a gross tonnage of 50,000. It is claimed that 4250 passengers can be accommodated in addition to a crew of 1000. The engines will develop 70,000 horsepower.

## A UNIVERSAL INDICATOR

By H. V. PURMAN*

One of the most necessary tools in the jig-maker's kit is the indicator. With the micrometer he can determine sizes and with the height gage, set buttons, but without the indicator he would be at a loss to know when his button is running true and when the bored hole will be in the correct position. There are also many other uses for the indicator, such as setting a surface "level," aligning a piece of work parallel to the travel of any moving part of the machine, or finding the offset between two surfaces. These matters can be determined by other means, but the quickest way is to use the indicator. When it comes to setting work on a lathe faceplate so that a button previously set will run absolutely true, the indicator is indispensable. It is with the idea of assisting mechanics who may need such a tool that the following description is given.

The indicator shown in use in Fig. 1 and assembled in Fig. 2 was designed by Mr. F. A. Turner, who for many years was foreman of experimental and jig work in the United Shoe Machinery Co., of Boston and Beverly, Mass. It is through

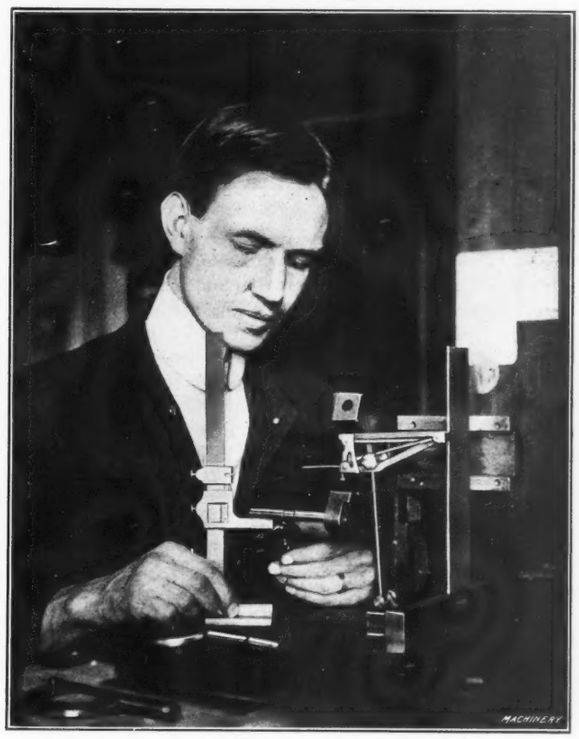



Fig. 1. The Indicator in Use as a Height Gage

his kindness that the author was enabled to make a duplicate of the original for his own personal use. This is not the best indicator made, that honor belonging to the Boulet indicator made by Mr. J. H. Boulet of Beverly, Mass., but after a wide experience and familiarity with many indicators of the dial, arc-and-lever classes, the writer would say that this indicator is second best.

Referring to Fig. 2, *A* is the frame, made from 1/16 inch bright-finished sheet steel, cut out light, and of a slightly ornamental design. It is drilled and tapped for six headless pointed screws, which hold the three pivots *B*, *C* and *D*, in which the levers are located. The motion of the work is transmitted by the finger *E* through links *F* and *G*, and rod *H* to the pointer *I*. *E*, *B* and *F* form a bellcrank operating a second bellcrank *G*, *C* and *H*, simply by means of the contact between links *F* and *G*, the contact points being hardened to reduce wear. Lever *H* supports and operates needle *I* by means of a cross-pin *M*, driven into the needle, the latter being held in the pivot *D*. The free end of needle *I* is reduced to an arrow head and swings over the graduated arc *J*. Lever *H* and needle *I* are made of aluminum, thus requiring

* Address: Winchester, Mass.

little power to move them, and consequently making the indicator very sensitive. The other working parts are all made of steel. A small music wire spring *K* is secured to the frame and rests upon the cross-pin *M* in needle *I*, thus confining the motion of the latter to that actually given to it by lever *H*. This spring allows the indicator to be used in any position—upside down, sidewise or vertical. The indicator may also be rotated in the spindle of a machine to bring a hole or boss central with the spindle, but when it is used in the position shown in Fig. 2, the spring *K* is removed from the pin *M*

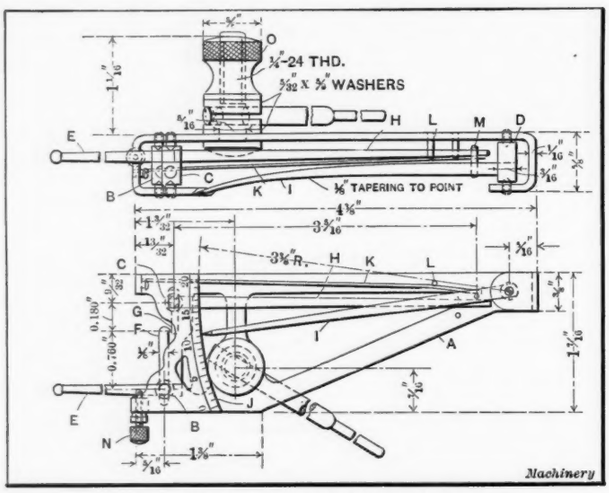



Fig. 2. Assembled Views of the Indicator shown in Fig. 1

and placed on the pin *L*, which also restrains the upward motion of lever *H*. This allows the indicator to return by gravity, and makes it more sensitive and delicate in its action. An adjusting screw *N* fitting in a nut brazed onto the frame serves to restrain the downward motion of finger *E*, and thus checks the fall of the needle *I* at any desired point on its arc.

In use, the indicator is held by the clamp *O* on a 3/16-inch rod, of which a number are provided with the different holders. One of the additional clamps used, which fits onto the tool held in a lathe or planer, is shown at *A* in Fig. 3.

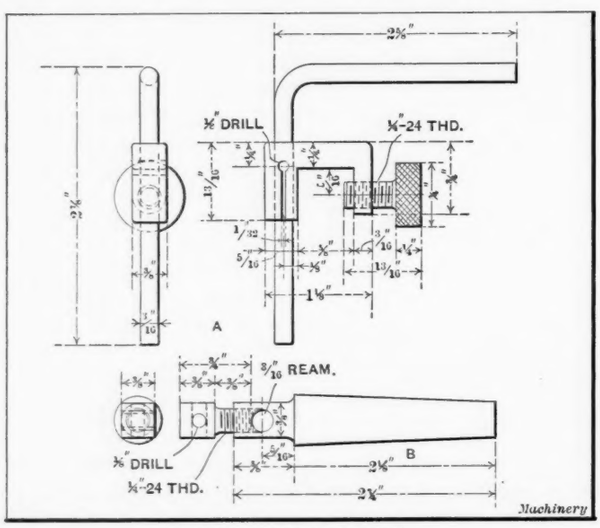



Fig. 3. Special Indicator Holders

Another holder for the indicator is the stem shown at *B*, which obviously fits in a sleeve in the lathe, drilling or milling machine spindle.

Some additional fingers for the indicator are shown in Fig. 4. The larger end of the shouldered rod *A* fits in the indicator clamp, and the small end is reduced to fit in the universal surface gage, thus permitting the use of this tool on the surface plate as a sensitive surface gage. The clamp *O*, Fig. 2, fits directly on the spindle of the small universal toolmaker's surface gage. Rod *A*, Fig. 4, however, is also useful in reaching over projecting obstructions, and allowing the use of the indicator in every conceivable place where its size permits or the fingers will reach. The "reach" of the indicator is greatly augmented by the additional fingers shown at *B* and *C*, which are interchangeable with the finger *E*, Fig. 2, and will reach over a projection.

The indicator is especially useful on the surface plate on points inaccessible to the height gage. The height may be taken on the indicator and transferred to the height gage as shown in Fig. 1. The additional finger *D*, Fig. 4, fits into the clamp *O*, Fig. 2, and extends out above and in line with the ball end of the finger *E*, Fig. 2. It is adjustable by swinging the clamp *O* to any desired position, thus making the tool a sensitive indicating inside caliper, which will reach where an inside micrometer could not enter. The reading can be noted, then the indicator withdrawn, and the needle *I* (Fig. 2) brought to the same reading by closing the micrometer caliper over the contact points, when the size of the hole or opening can be readily obtained.

This indicator, by actual test, has proved readily sensitive to the 0.00025 inch; that is, a motion of 0.00025 inch is magnified into a movement plainly discernible at the needle tip, the multiplication being 70 to 1. The arc on the indicator is slightly in excess of 1 7/16 inch in length and a space 1.4

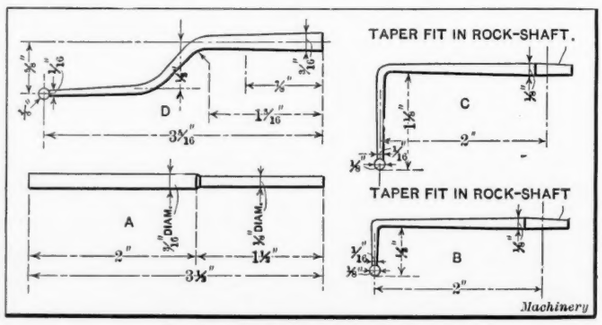



Fig. 4. Additional Rods and Fingers

inch long is marked off on it, the levers being so adjusted that the needle *I* moves that distance while the tip of finger *E* (Fig. 2) is moved 0.020 inch. The ratio then is $\frac{1.4}{0.020}$ or 70; therefore, as the arc is divided into twenty equal spaces, each space represents a movement of 0.001 inch.

* * *

## ENGLISH CRANKPIN TURNING MACHINE

By FRANK C. PERKINS*

In Manchester, England, a novel machine has been designed for the rapid and accurate machining of crankpins, as shown in the accompanying illustrations, Figs. 1 and 2. The principle involved in the method adopted in this new machine is that of actually "forming" the crankpin by means of a tool which is the full width of the crankpin. To render this method of turning possible, a positive drive, as close to the crankpin as possible, is absolutely necessary, and this is one of the features of the design.

This machine consists of a headstock with a large hollow spindle, carefully and accurately fitted. The spindle is actually a drum, large enough in internal diameter to accommodate one end of the crankshaft, when supported eccentrically according to the required throw of the crank. On the face of this drum is mounted a special chuck which determines positively the exact throw of the crank. The crankshaft is supported in the chuck close to the web. Inside the spindle it also rests in a special "steady-disk" which can be moved to any point to suit the length of the crank. In addition to this, the crank is further held by the web by means of clamping screws on the face of the chuck, thus eliminating all torsional stresses in the crankshaft.

The headstock drum or spindle carries on its outer end a large helical gear, which is driven by a pinion on the end of the main spindle of the gear box. The main drive to the machine consists of one pulley only, 16 inches in diameter, for a 4-inch belt, running at 350 revolutions per minute. All

* Address: Erie Co. Bank Bldg., Buffalo, N. Y.

speed variations are obtained from a system of gears carried in the gear box mounted on the headstock. This gear box gives eight speed changes arranged in geometrical progression, the speed changes being obtained by means of interlocking levers. These levers prevent the possibility of two speeds being simultaneously engaged and thus damaging the gears. The headstock is carried on a ribbed bed of box section, the interior of which is used as an oil well for the cutting lubricant, and provision is made for the returning of the oil to the well after leaving the cutting tools.

The machine is provided with a long cross-slide; on the front end of this is mounted a tool-holder which carries the roughing tool. A second tool-holder, carrying the finishing tool, is mounted behind the crankpin, so that the turning operation can be entirely completed without removing either the crank or the tools. In addition to the "necking" tool-holder, a "crowning" rest is also provided, at the back of the cross-slide, for the purpose of crowning the ends of the crank webs. Both the cross-slide and the crowning rest have the necessary automatic feeds. For "crowning" the webs, the crank is held in the same chuck as for the necking, but to obtain the correct position for this operation, a second hole is provided in the chuck to receive the crankshaft.

It is claimed that the pins are finished true within a maximum limit of error of 0.0005 inch. There is perfect control

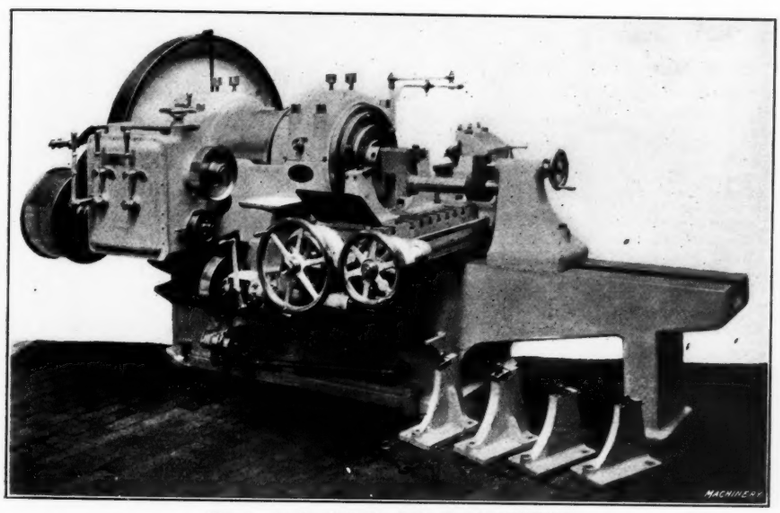


Fig. 1. An English Crankpin Turning Machine

of the finishing tool, the diameter of the crankpin being readily and accurately controlled by means of a large graduated disk on the feed-screw. When the disk is once set, the correct

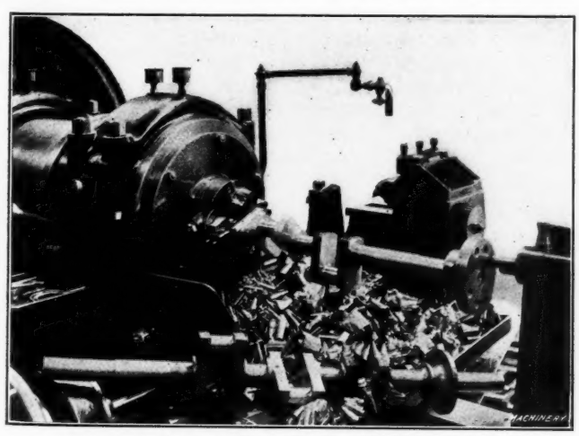


Fig. 2. Example of Chips taken when Turning Crankpins

diameter can be reproduced any number of times without actual gaging.

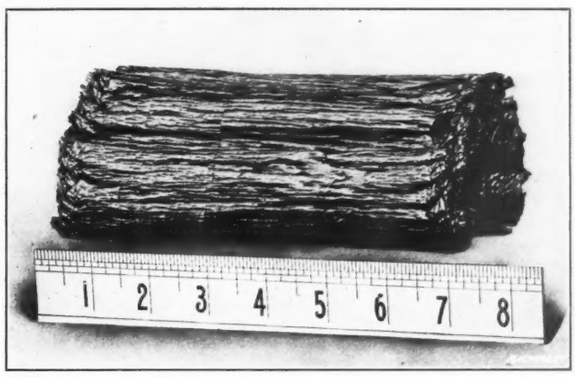
* * *

The business of a modern engineering concern has been tersely expressed as that of translating the brains of the engineers into mechanical devices and methods, and selling them to the world.

## CRANKSHAFT TURNING*

By "NOMAD"

The writer has followed with interest the articles in the January and March, 1911, numbers of MACHINERY, referring to




Chip taken when Finishing Crankpin on Crankshaft Turning Machine

the rough turning *vs.* rough grinding of crankshaft pins. I am personally interested in grinding and grinding machines. Mr. Norton's comments appealed to me very much, and upon a visit to the shops of one of the largest oil- and gas-engine manufacturers in England, a firm which also has an international reputation, I called attention to this matter. It was apparent that my remarks aroused a certain interest, for upon finishing, the shop superintendent said, "We have a machine here that both roughs and finishes our crankpins at the same setting; this machine was especially made for this purpose." I was then shown the machine, and it certainly was a revelation. The crankshaft passed through the center of the driving-head, and the pin being machined was as close to the head as practicable, and was supported in a plate in the end of the tail-stock. The crankpin was roughed down and brought to a cylindrical shape by a coarse hand feed, at a cutting speed of about 90 feet per minute. After that, the machine was run at a very slow speed, not more, it seemed, than four revolutions per minute, and a finishing cut was taken with a plain broad forming tool, the crankpin being finished in this manner to the exact diameter and shape.

I was shown a pile of a dozen or more four-throw crankshafts, which upon inspection appeared to be all that could be desired. While I still hold my opinion as regards grinding crankshafts and similar parts, it is evident that one cannot lay down hard and fast standard rules for machining, as there is and always will be a difference of opinion as to the best practice, even for work of so general a nature as crankshafts. The accompanying illustration shows a chip taken during the finishing cut. It is approximately seven inches wide.

* * *

The manufacture of gasoline from natural gas is a profitable and comparatively new industry that is being developed in the oil regions of New York, Pennsylvania, West Virginia and other states that produce large quantities of gas. The gasoline is extracted from the gas by compression and cooling, the pressure varying somewhat with the quality of gas, 150 pounds being a common pressure. The gas is pumped from the line, treated and returned to the line freed of the hydrocarbons that burn with smoke and deposit soot. While the treated gas is thus somewhat more desirable for household use than untreated gas, it does not burn with quite as hot a flame in gas stoves. According to an article on the subject by Mr. F. W. Brady in *Mines and Minerals*, the product from 150,000 cubic feet of gas is 500 to 800 gallons of gasoline, 92 degrees Baumé.

* See MACHINERY, March, 1911, "Rough Turning *vs.* Rough Grinding of Crankshaft Pins," and January, 1911, "The Field for Grinding."

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Erik Oberg, Franklin D. Jones, Douglas T. Hamilton, Chester L. Lucas, Associate Editors

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We solicit contributions from practical men on subjects pertaining to machine shop practice and machine design. All contributed matter published exclusively in MACHINERY is paid for at our regular space rates unless other terms are agreed on.

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper, $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

## THE FARM TRACTOR

The success of the internal combustion engine as applied to automobiles and trucks for hauling merchandise, has naturally caused many minds to study the possibility of developing tractors for hauling plows, harrows, seeders and other implements on the farms. Traction engines have been used with marked success for years on the big ranches of the West, but they are too costly and cumbersome to be bought and used by the farmers working one hundred to two hundred acres of land.

The tractors that will have an enormous sale will be those selling for four to five hundred dollars, and capable of developing ten to fifteen horsepower. They must be adaptable not only to haulage but to stationary uses as well, such as cutting hay or straw, grinding feed, sawing wood, pumping water, etc. Tractors of this type will enable farmers keeping, say, five horses, to do their seeding and harvesting, to dispense with three and save the cost of keeping them through the winter and other idle periods of the year.

The importance of the farm tractor manufacturing business is shown by the large amounts of capital already invested in it, and the probability is that the present capitalization will be largely increased within the next five years.

* * *

## FORM GRINDING

A branch of machine work that is acquiring considerable importance, especially in the automobile industry, is form grinding other than flat or cylindrical shapes. The features of form grinding machines are wheels of the contour required on the work piece and means for constantly maintaining the correct wheel shape. It seems assured that machines of this type will become important factors in mechanical production, unless methods of heat treating steel are devised which will insure that no distortion takes place after the ordinary machining methods are completed. Even if such a discovery should be made there is still the probability that the grinding process will develop commercially because of inherent advantages. These have been amply demonstrated by the grinding of automobile crankshafts from the rough at a rate that puts the best lathes to the test to equal. Form grinding simplifies the production of parts that have integral splines, such as sliding gear transmission shafts, and enables them to be produced within limits of accuracy that are hardly obtainable commercially in any other manner. Not to mention hardened gears which of course are the most important examples of form grinding, there are innumerable other hardened parts used in manufacturing that can be advantageously finished thus when made in large quantities.

* * *

## SCIENTIFIC MANAGEMENT IN THE SEVENTIES

James W. See in his famous "Chordal's Letters," published over thirty years ago, tells a story of Pratt & Cady who were "up against it" after the panic of 1873. They were building a steam engine on the cut-throat competition basis. The men were working for small wages and the firm was selling few engines, despite the fact that the selling price was pared to the bone. One day a Yankee from down East appeared on the scene, and after some dickering made a contract to build the engines in the firm's own shop at a price far below what they were then costing, and guaranteed his offer with a cash forfeit.

The story of how Doolittle, the contractor, organized the work, provided jigs and cut the costs, and at the same time raised the pay of the men is interesting reading to-day. It sounds so much like what we hear in the talks on scientific management, that we are forced to conclude that Doolittle, in the guise of a contractor, was really an efficient superintendent, hired at a salary far beyond what Pratt & Cady would have paid, to reorganize the building of steam engines to meet the conditions of the times and make money for the firm, himself and the men. His success did not hinge on card systems, forms, work tickets, time study or functional foremen; but he undoubtedly used some of the principles, if not all of them, which have made for success in modern management. The point is that the substance of successful management must be separated from the clothes or forms in which it appears in various industries in order that the average man can grasp and understand it.

* * *

## BALL AND ROLLER BEARINGS IN MACHINE TOOLS

Ball bearings have been used in machine tools for several years in a conservative way, and the results have been generally satisfactory. The time has come when we may confidently expect to see them used to a much greater extent with a resultant saving of power and preservation of accuracy through the general elimination of wear.

It is not perhaps to be expected that ball or roller bearings will be generally applied to such parts as lathe spindles. While they have given excellent results in severe service, the jar and vibrations of heavy intermittent cuts would prejudice most mechanical engineers against their use. But even if the main bearings of working spindles are hardly feasible places to apply them, there are many other plain bearings in lathes, milling machines, drilling machines, and other machine tools, that could be displaced by anti-friction bearings with large resultant saving of power. The fact is that the power lost in friction in machines is not absorbed as much in the spindle bearings as in the transmission parts running at high speed.

One well-known maker of annular ball bearings supplies data sheets showing methods of applying ball bearings to almost every conceivable situation; and designers of machinery generally and of machine tools in particular should not neglect these important suggestions for eliminating waste effort. Probably the greatest waste in the mechanical world is caused by friction. Friction wears out machinery and wastes coal without accomplishing useful work. Wide-awake designers should provide the means whenever possible and feasible to conserve power and thus prolong the life of the machines they design.

## THE GAS ENGINE INDUSTRY

One of the busiest metal-working industries of the present is the manufacture of small stationary internal combustion motors for farmers and other users of small power. The Middle West is absorbing great numbers, and the capacities of engine plants is being increased to meet the demand. One concern in Illinois has doubled its capacity twice within a year, and is now equipped to turn out two thousand engines a month.

The gas engine is displacing the windmill because of its greater reliability, compactness, movability and lower initial cost. It is true that the gas engine is a source of expense for fuel and lubricant when in operation, but it is subject to fewer deteriorating influences. The windmill is at the mercy of the elements. Every high wind leaves in its path broken and dismantled wheels and wrecked towers. Towers without wheels are a common sight in the prairie regions of the West, mute evidences of destructive storms.

The growth of gas engine building has been rapid and has acquired great commercial importance, but it will assume far greater importance in the near future. The perfection of kerosene engines suited to agricultural and similar uses is practically assured, and that will give a tremendous impetus to the use of internal combustion engines generally. Kerosene is now a by-product with the oil refiners, the consumption of gasoline having so increased within a few years that the two products, both relatively and actually, have exchanged places in commercial importance. Kerosene is the more ideal fuel for engines, being obtainable everywhere and much safer to handle. Eventually crude oil may displace both as fuel for internal combustion engines, large and small. The importance of the gas engine business when that era is reached can only be guessed at now.

* * *

## AUTOMATIC VS. HAND MACHINES

The development of automatic machinery in America has been the wonder of the world. Since Spencer invented the automatic screw machine in the seventies, the trend of machine tool design has been toward automatic machine tools of every kind. The inventive genius of the country has been largely concentrated on the problem of eliminating hand labor by making the machine perform all the operations necessary to complete a part without the guidance of an operator. Every improvement that makes the control of a machine easier and quicker is a manifestation of this tendency. Power traverse of slides, spindles, and cross-rails, and quick-change speed and feed boxes, are examples. Full automatic machines that turn out tiny watch screws from wire or massive machine parts from six-inch bars are commonplaces, as are the machines that completely machine a casting after it has been placed in the chuck by the operator.

The high cost of labor and the difficulty of getting trained men when the demands for product are imperative are potent reasons for the existence of automatic machinery, but besides that is the incentive to equip factories with special machines that are supposed to be the last word in mechanical development. In short, there is something of faddism in it.

The question of providing automatic machines for many kinds of work is one that should be carefully weighed. Is the quantity of work to be produced large enough to keep the machines employed? Will the cost of supervision and equipment outweigh the saving in labor? Are the machines adaptable to other work than that for which they are purchased?

The problem is one similar to that which perplexes many builders of machine tools themselves:—"To jig or not to jig; that is the question." No one questions that jigs and fixtures should be provided when the quantity of machines to be built runs into thousands, but where a design is subject to change after fifty or a hundred machines are built, the cost of changing the tool equipment may be greater than the saving effected by it. In other words, manufacturing on a large scale and automatic machines go together; but building machinery is generally best carried on with adaptable tools operated individually. Provide the machines with labor-saving features generally, but let their functions be readily changed to suit the work in hand.

## SELLING MACHINE TOOLS BY DEPARTMENT STORE METHODS

The echoes of Prof. Cardullo's* ball-pein hammer have been heard in various machinery centers during the past month, and his article in December MACHINERY has apparently had the desired effect. But the professor hammered a hole right through his own proposition when in the same paragraph he advocated direct contact between manufacturer and consumer as well as department store methods for selling machine tools; because the most prominent and successful intermediary between manufacturer and consumer is the modern department store—represented in the machinery industry by the dealer. And Prof. Cardullo's argument was not helped by the comparison which naturally suggested itself between the character of the selling forces employed by machinery dealers and by department stores where the selling ability is frequently limited to furnishing the price of an article that is marked in plain figures. The largest and one of the best department stores in New York City is noted in the writer's family for certain peculiarities in handling correspondence which throw Prof. Cardullo's examples into the shade. This department store seldom spells our name right, even on receipts for money, although we have had an account there for twenty-four years; it usually requires a week to ten days to answer an inquiry; it seldom has just the right shade of material and never offers to get it. Its correspondence is usually conducted on postcards in grammar school hand-writing and phraseology. Yet those in authority are always courteous and obliging, when they are reached. The trouble is with the kind of help they employ.

There are all kinds of machinery salesmen, from those like Prof. Cardullo's jig friend up to the cracker-jacks, whom we all know but won't name, because present business conditions do not warrant salary increases. First-class machinery salesmen are hard to get. They all have jobs, and their bosses are not letting them go. Many of them came up through the shop, where they thoroughly learned the mechanical end of their business; then they developed selling ability on the road and formed an acquaintance among machinery users which is one of their most valuable assets. Somewhere between these men and Prof. Cardullo's horrible example will be found the average machinery salesmen.

A few of the things Prof. Cardullo says sound queer to the writer, who is neither a manufacturer, a dealer, nor a consumer, and therefore unprejudiced. For instance, his proposition that machine tool builders should advertise the price of their machines like shoes or corsets, and that the man who wants to buy one should work one manufacturer against another, getting "concessions" until the price is low enough to suit, would make even a publisher laugh. That is certainly not a department store method.

Then Prof. Cardullo says: "If the price is higher than that of his competitor, the reader naturally looks to see if the article is not a better one, and if it is not better than the one he contemplated purchasing, he will give his order to the manufacturer who advertises his price." How can Prof. Cardullo "look to see" which is the better tool when the manufacturer may be a thousand miles away, and when he has eliminated the local machinery dealer where one of the machines could have been seen? The department store method would be to have a stock of tools all marked in plain figures—a $500 lathe would be $499.98, and a $1500 milling machine $1498.64. You could then take them or leave them; the department store makes no "concessions" on its prices.

Possibly Prof. Cardullo means to rely on *reputation*, which is acquired through quality and publicity—one is just as essential as the other, and both cost money. But besides reputation the successful manufacturer must have a marketing organization of some kind through which he can follow up inquiries and quickly reach possible buyers of his machine some of whom don't know they need it. The writer's observation shows that, generally speaking, the most successful manufacturers of standard machine tools are those who are represented by the best dealers. Take two standard tools of equal

* Prof. Forrest E. Cardullo, Department of Mechanical Engineering, New Hampshire College of Agriculture and the Mechanic Arts, Durham, New Hampshire.

merit, equally well known, and priced about the same; and the one represented by the best line of dealers will outsell the other. Every manufacturer knows this, and those who are not satisfactorily represented in the industrial centers, or not represented at all, are constantly looking for good dealers to handle their line; but the supply is below the demand. There

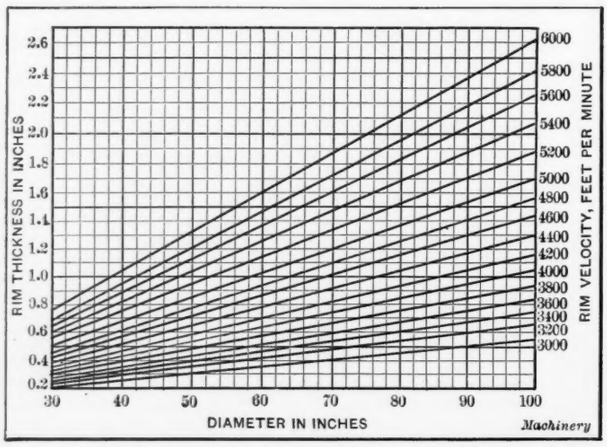


Fig. 1. Diagram for Finding Thickness of Solid Flywheel Rims, Six Arms

are fifty makers of engine lathes in the United States, and in New York City not over six, strictly, machine tool dealers.

It is almost elementary to say that no engine lathe manufacturer can market his product economically except through dealers or agents who handle a sufficiently varied line of machine tools to warrant the expense of covering their territory through systematic traveling. This method of selling tools may be all wrong. It certainly can be improved; but it is the fault of the buyer more than of the manufacturer. There

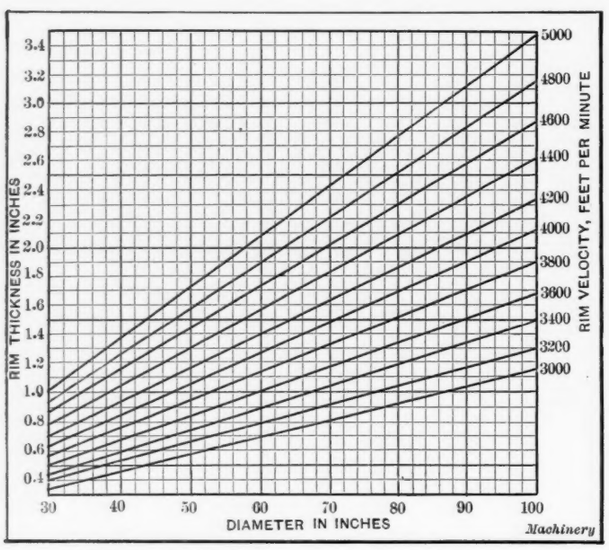


Fig. 2. Diagram for Finding Thickness of Jointed Flywheel Rims, Six Arms

is hardly a machine tool builder who would not prefer to sell his product direct, but it is not practicable except in the case of special machines, automatics and the like, which are sold at a sufficiently higher price to carry the extra selling cost.

Competition makes it necessary to cover the country thoroughly through travelers, and this condition has brought into existence the expensive organizations which the various dealers maintain. One firm of dealers covering a comparatively limited territory employs twenty-two trained men at an average outlay for each, including salary and traveling expenses, of $4000 a year. Dealers covering the entire country have much larger organizations. There are advantages to the manufacturer besides that of economy, in selling through dealers. The latter carry a stock which is usually paid for in advance of sale, releasing a large amount of capital which the manufacturer would otherwise have tied up. The dealer can often make a sale by taking old tools in part payment for new ones, and disposing of the former, which, of course, cannot be done by a manufacturer.

There is truth in some of Prof. Cardullo's criticisms of methods; but most of them apply to small manufacturers who are their own foremen and office force. A man may possess the mechanical ability to design and construct a machine of unusual merit, and yet be unable to describe it satisfactorily in an advertisement or letter. The larger manufacturers do not handle their inquiries in the way he described.

If Prof. Cardullo will come to MACHINERY'S Outing or Inning he will meet a large detachment of the "army" including a number of the generals; and when they are not engaged in lapping up cream or other things, they will doubtless be glad to impart to him some ideas that may change his point of view.

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## THICKNESS OF FLYWHEEL RIMS*

By E. D. GAGNIER†

The tendency of a flywheel rim when revolving is to bow out between the arms. With thick rims this condition does

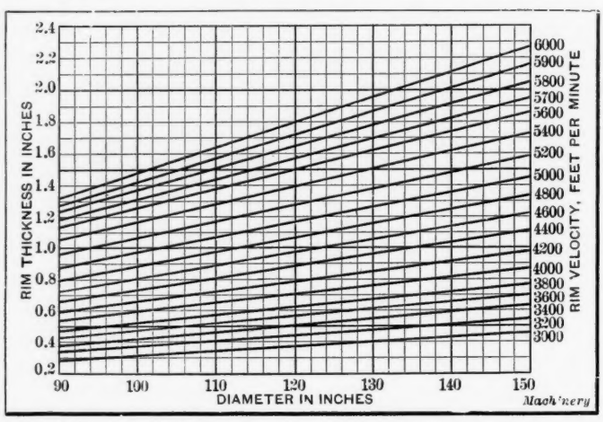



Fig. 3. Diagram for Finding Thickness of Solid Flywheel Rims, Eight Arms

not need to be considered, but in the case of a thin rim running at a high rate of speed, the stress in the metal might become sufficiently great to cause the wheel to fail. The proper thickness of a cast-iron rim to resist this tendency is given by the following formula:

$$t = \frac{0.475\,d}{n^2\left(\frac{6000}{v^2} - \frac{1}{10}\right)} \qquad (1)$$

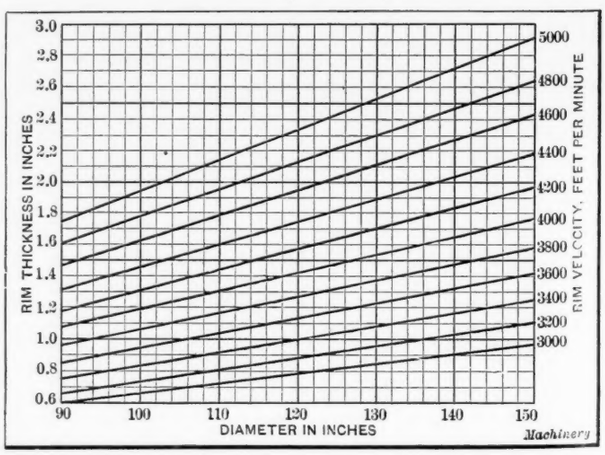



Fig. 4. Diagram for Finding Thickness of Jointed Flywheel Rims, Eight Arms

for a solid rim; and

$$t = \frac{0.95\,d}{n^2\left(\frac{6000}{v^2} - \frac{1}{10}\right)} \qquad (2)$$

* For additional information on this and kindred subjects, see MACHINERY, November, 1910, engineering edition, "Flywheels for Internal Combustion Engines," and other articles there referred to. See also MACHINERY'S Reference Book No. 40, "Flywheels."

† Address: 356 East High St., Salem, Ohio.

for jointed rims. In both formulas

$t$ = thickness of rim in inches,
$d$ = diameter of wheel in inches,
$n$ = number of arms,
$v$ = peripheral speed in feet per second, and
6000 = permissible stress in pounds per square inch.

The first formula was given by J. B. Stanwood in a paper read before the American Society of Mechanical Engineers in 1893. It will be noticed that the values of $t$ in Formula (2) are just double those in Formula (1). Prof. Gaetano Lanza, in a discussion which followed the previously mentioned paper, gives the value of the constant in the second formula as 1.424; and in the same paper Mr. Stanwood used 0.712. However, it is the practice of an old engine-building concern to use the value 0.95.

The values obtained from these formulas are shown plotted in the four accompanying engravings, which cover both solid and jointed-rim flywheels having either six or eight arms. A rim speed of 6000 feet per minute, gives a stress in the metal due to the two halves of the rim tending to pull apart, of nearly 1000 pounds per square inch, beyond which it is unsafe to proceed. As a jointed rim is not as efficient as one that is solid, the value of 5000 feet per minute for jointed rims has been used in plotting the curves for flywheels with this kind of rims. With very thin rims, where the joint is heavy in proportion to the rim, a speed of 4500 feet per minute should not be exceeded.

* * *

The Cadillac Motor Car Co., Detroit, Mich., has a plant organized on the departmental system by product. Each department has, in general, the equipment needful for furnishing the work that it does on a unit. A feature of the work, interesting from the viewpoint of cleanliness, is the practice of dipping castings and other parts into a boiling soda solution after each major operation to clean off the chips and oil. Thus each part goes to the next operation thoroughly clean and agreeable to handle. The practice promotes turning out work with the accuracy for which the concern is noted.

Fig. 1. Erecting Department, J. E. Reinecker Works, Chemnitz, Germany

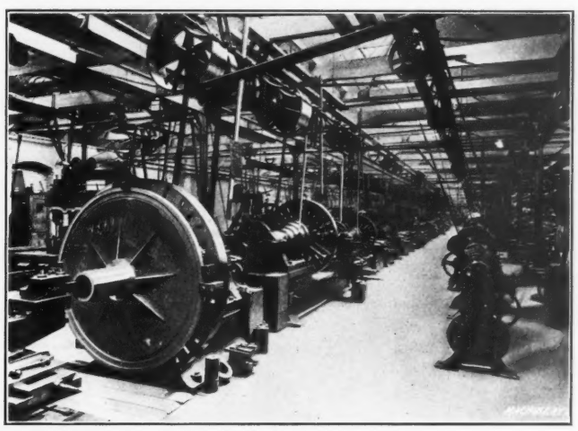


Fig. 2. Lathe Department

Fig. 3. Milling Department

Fig. 4. Relieving Lathe Department

# THE J. E. REINECKER WORKS AT CHEMNITZ-GABLENZ

## MODERN GERMAN METHODS AND DESIGN IN THE PRODUCTION OF HIGH-GRADE SHOP TOOLS

By C. A. TUPPER*

With Düsseldorf and Berlin, the industrial district of Chemnitz, in Saxony, forms one of the most interesting parts of the German Empire for an American, Canadian or English machinery manufacturer to visit. Here he has an opportunity of going through numerous modern metal-working plants, including the Wanderer Fahrradwerke, the Werkzeugmaschinenfabrik Union, the shops of Biernatzki & Cie and of Schubert & Salzer, the Sächsische Maschinenfabrik and others, and will be given a particularly cordial welcome at the recently extended works in Chemnitz-Gablenz of the firm of J. E. Reinecker, now composed of the sons of the founder, *viz.*: Johannes G., Julius Richard and Paul Alfred Reinecker. This business, which was started in a small tool shop in 1859, and will be remembered by many Americans as having been represented by one of the principal exhibits of Germany at the World's fair in Chicago, 1893, now commands over 400,000 square feet of working floor space, with shops that are among the best appointed of any in the world.

Fig. 1 shows the interior of the erecting shop for the larger tools, nearly 670 feet in length, which forms, as it were, the backbone of the works. This is known locally as the "large machinery hall." Opening into it at right angles from each side, are the various manufacturing departments. In addition, there is, at the left, an older group of shops. This group is connected with the new section by the former erecting department, now used for the smaller machines, which runs parallel with the large erecting shop. Thus, the whole system is "interlocking," and the work progresses along clearly defined paths, without any retrogression, confusion, or loss of time. The main erecting shop is three stories high, with a

* Address: 389 Thirty-first Ave., Milwaukee, Wis.

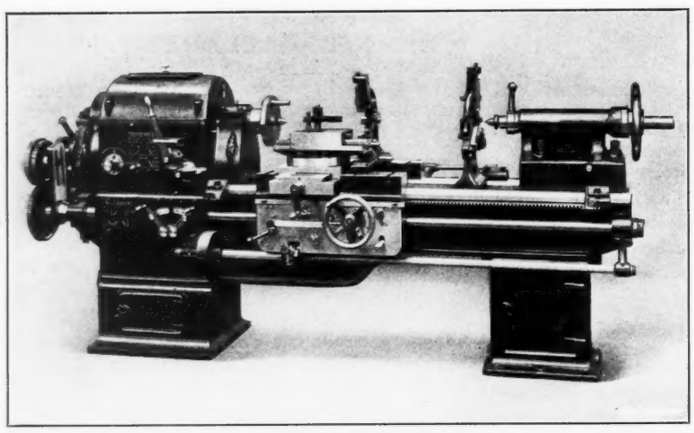


Fig. 5. Recent Design of High-speed Engine Lathe

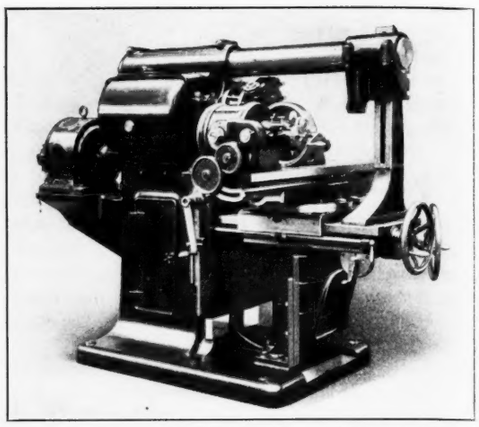


Fig. 6. Universal Milling Machine with Electric Drive

lofty roof, while the machine shops are two stories high, with a central peaked skylight extending the length of each. The smaller erecting shop is similarly constructed but with more head-room. Leaving, until later, a closer inspection of the details revealed by Fig. 1, let us take up the other departments.

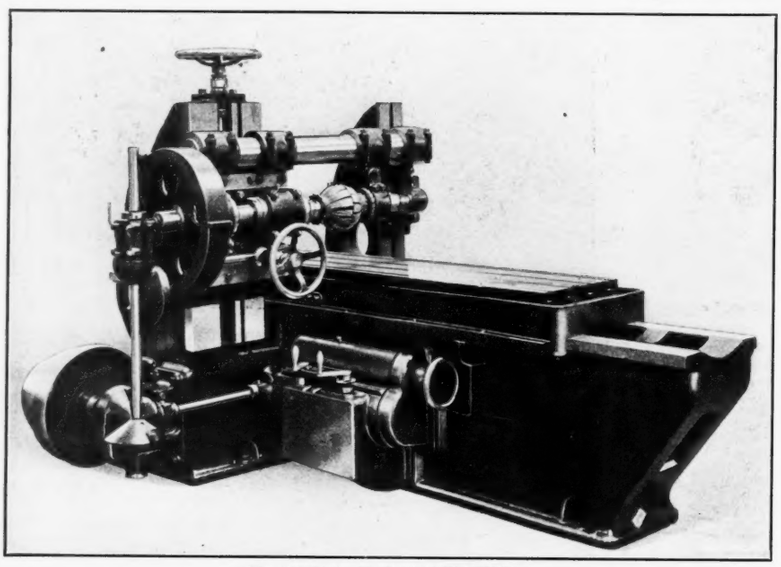


Fig. 7. Plain Horizontal Slab Miller

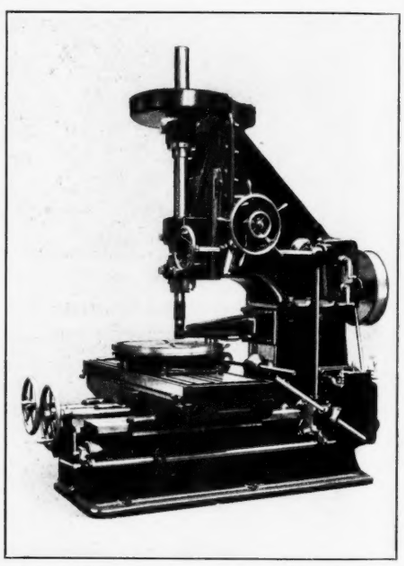


Fig. 8. Latest Design of Vertical Milling Machine

Fig. 2 shows the rows of heavy lathes driven from shafting, each line of which is actuated by a motor at the end, which is not here shown. At the extreme right, just visible in the halftone, are row upon row of speed lathes similarly arranged. For the larger machines, tight and loose pulleys will be observed on the driving shafts, while for the smaller lathes friction clutches are used. The standard engine-type lathes made by the Reinecker firm, itself, include three styles and twenty-one sizes, for all classes of work. Some of the designs are distinctively German, while in others various features of English and American practice have been followed. The greatest importance is attached to the use, even for the simplest styles, of the best material obtainable for each detail. As an example, the main spindles are made of hammered steel, having a tensile strength of 137,000 to 145,000 pounds per square inch. A similar policy has been pursued with reference to the other tools mentioned in this article. Special engine lathes are built according to specifications.

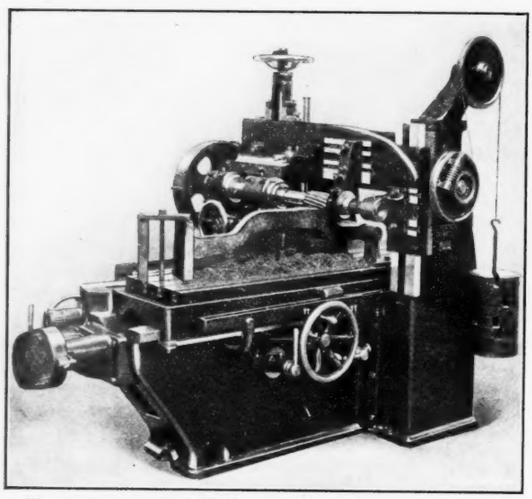


Fig. 9. Profiling Slab Milling Machine for Milling Locomotive Connecting rods

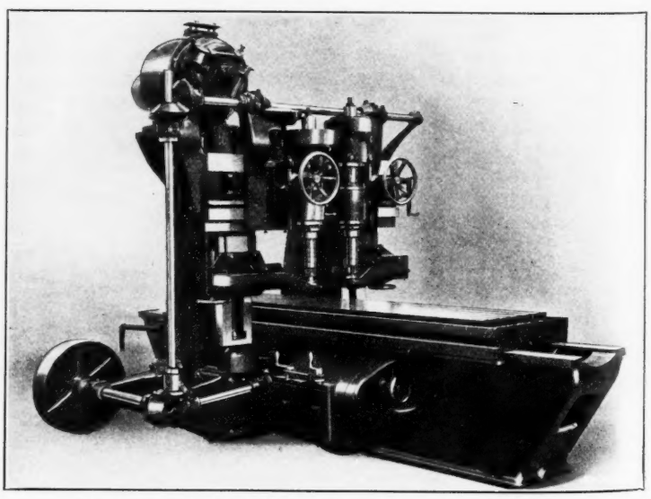


Fig. 10. Vertical Slab Milling Machine for Milling Locomotive Axle Boxes, etc.

High-speed sliding, surfacing and screw-cutting lathes are made in two styles and twenty-four sizes, adapted to every class of service. The lighter machines have both lead-screws and feed-shafts, while the heavier are provided with a splined lead-screw, which for screw cutting is driven by change gears, but for ordinary sliding and surfacing, by a belt and step cones. A feature of these machines of value in the export trade is the fact that both English and metric screw pitches, according to the Whitworth or International systems, can be cut on all Reinecker speed lathes by the use of suitable change gears. Plain "capstan" and turret lathes, combination turret lathes, and special machines of this type, for stud and stay making, are also manufactured.

American lathes, including purchases made some time ago from the New Haven Mfg. Co., Prentice Bros. Co., Gisholt Machine Co. and F. E. Reed Co., have been quite largely used in these shops and their operating details carefully studied, together with English tools for the same classes of service from Alfred Herbert, Ltd., and others. The advantage of this practical observation is apparent in the Reinecker designs, dating

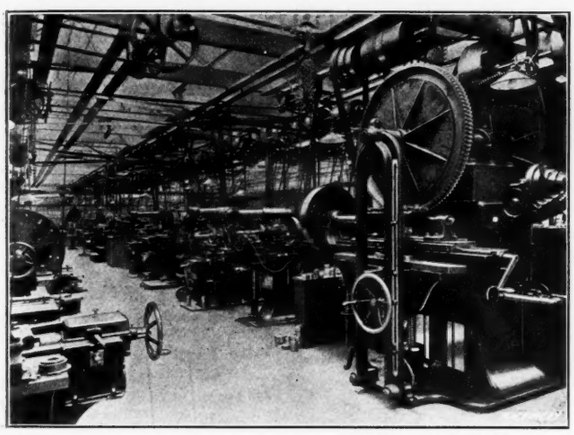


Fig. 11. View of a Portion of Gear-cutting Department

originally from 1898, one of the latest of which appears in Fig. 5.

In Fig. 3, a part of the milling department is illustrated. Here the method of driving and of obtaining the initial speed variation needed may be plainly seen. At the left of the machines shown are others considerably heavier. The manufacture of milling machines at the Reinecker works was entered into in 1893 and now embraces all types. They are designed, as most advertisers say, with a view to combining simplicity with convenience, durability and capacity for heavy duty. "For this reason," the Reinecker management naïvely remarks,

Fig. 12. Surface Grinding Machines at Work in Reinecker Shop

"many perhaps interesting but complicated ideas, which are found to a great extent in American machines, have been avoided." Plain, horizontal milling machines are made in six sizes, universal in eight, vertical in seven and slab or plano in five, with special types including parallel and duplex millers, nut and bolt-head millers, stud millers, slot millers, profiling millers, combination cam-shaft millers and grinders, twist drill millers, relieving millers, etc., in considerable variety. The line is certainly exceptionally complete, and the writer doubts whether it can be even approximately matched anywhere else in the world. Figs. 6, 7, 8, 9 and 10 show some of the newer machines that have been brought out. In Fig. 3 will be noted the arrangement for flooding the cutters with oil or soda-water, which is customarily furnished with Reinecker millers.

Fig. 4 illustrates a corner of the department devoted to backing-off or relieving lathes, the work done upon which will be

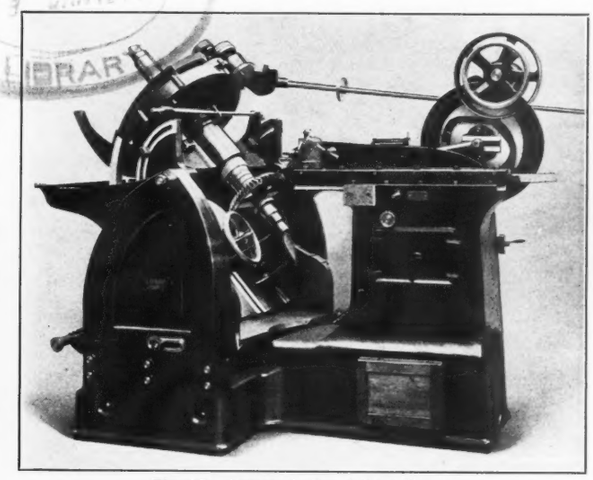


Fig. 13. Automatic Bevel Gear Planer

seen on the tables at the right. These lathes are worthy of a separate article, being perhaps the most distinctive and among the best of the Reinecker products. They are designed for relieving straight or spirally gashed milling cutters and also for side or axial relieving.

Fig. 11 shows a section of the gear and pinion cutting department, which is very extensive. Among the earliest machines used here were gear planers of the type brought out in Philadelphia, years ago, by the Bilgram Machine Works, the German rights to which, as the writer understands, the Reinecker

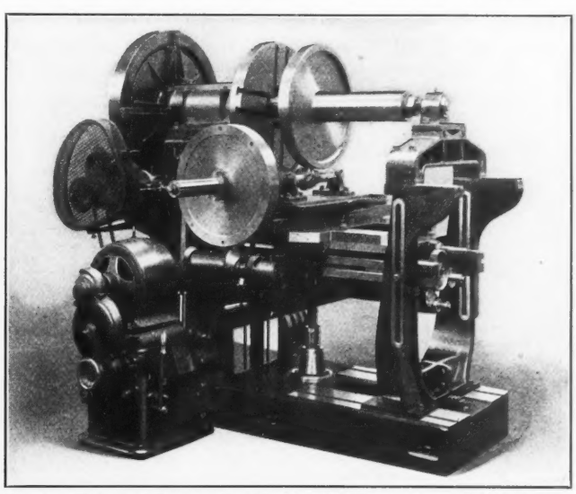


Fig. 14. Universal Gear-cutting Machine for Worm, Spur and Spiral Gears

firm secured; but the tools illustrated were manufactured in these shops, which now produce a line that, for completeness and apparently uniform excellence, rivals that of any toolbuilder anywhere. Certainly, it is the best in Germany. In Figs. 13, 14, 15, 16, 17 and 18, are shown examples of recent types. The line includes spur-gear cutting machines using either formed milling cutters or worm hobs; worm-wheel hobbing machines; universal machines for hobbing spur, spiral or skew gears and worm-wheels; worm milling machines also adapted for milling spur and skew gears; automatic and semi-automatic rack cutting machines; automatic and semi-automatic bevel gear planers; automatic bevel gear stocking machines; automatic spur gear planers; and tooth-chamfering machines for spur gears.

In Fig. 12 will be observed a row of surface grinding machines, also of Reinecker design, at work in their shops. The firm has had experience with the best American types, including those of the Norton Grinding Co., Wm. Sellers & Co. and others, and has taken due advantage of this in the construction of the tools now offered to the trade. They comprise plain and universal grinders and automatic cylindrical grinding machines, also such specialties as automatic tool grinders, caliper gage grinders, cam grinders, fillet and spherical surface grinders, internal grinders and attachments for similar work with other machines, ball race grinders, center grinders and various combinations for special purposes. There seems to be no limit to the ingenuity which these display. Figs. 19, 20, 21, 22 and 23 show examples of some of the types of grinding machines manufactured.

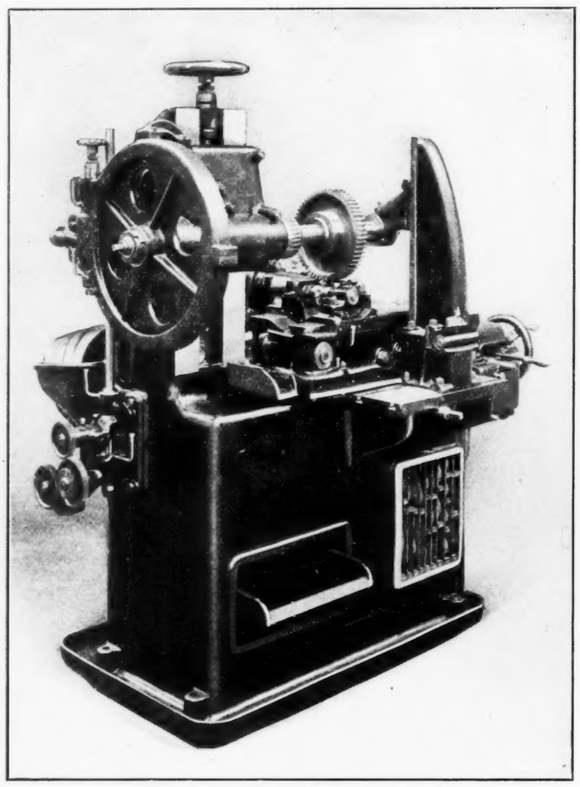


Fig. 15. Automatic Spur Gear Cutter

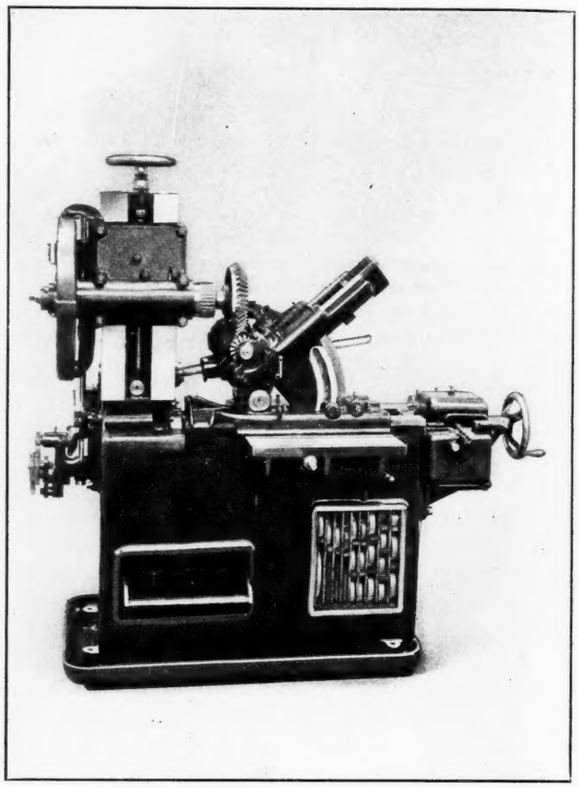


Fig. 16. Gear Cutter shown in Fig. 15, set for Stocking Bevel Gears

The Reinecker firm does not build planers for ordinary service but, naturally, there are in its shops many heavy machines of this type, and others of lighter construction, one of which, built by Ferdinand Kunao, Leipsic, impressed the writer favorably. Other departments of interest, illustrations of which cannot be given here, will be mentioned later. Two styles and two sizes of Reinecker vertical boring and turning mills, one of which may be seen partially erected in the right foreground of Fig. 1, are manufactured in these works. Other products include a special precision screw-cutting lathe, high-speed testing lathe, tool-room precision tap-making lathe, stud and shaft-turning lathes, and the dividing heads, special spindles, adjustable centers, indexing devices, chucks, etc., which go with high-grade tools.

Among American machines of types not manufactured by the

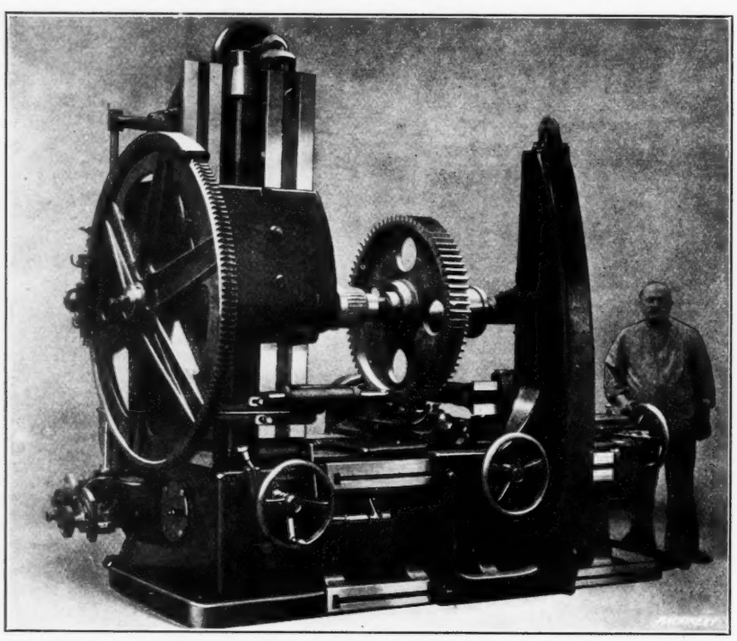


Fig. 17. Automatic Spur Gear Cutter with Vertical Adjustment of Slide for Large Work

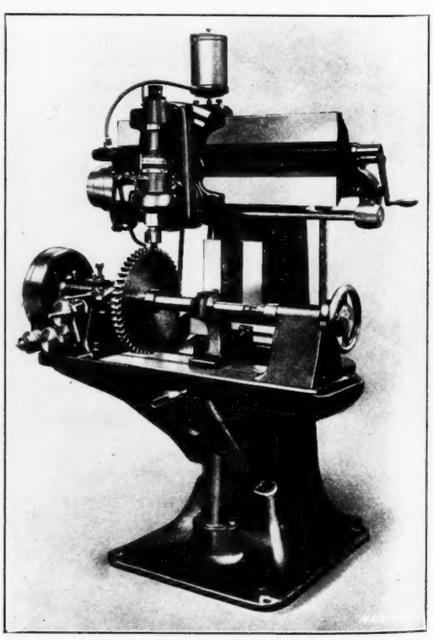


Fig. 18. Tooth Chamfering Machine for Sliding Gears

Reinecker firm, which have been in use in these shops, are drills from the Baush Machine Tool Co., Fosdick Machine Tool Co., H. G. Fish Machine Tool Co. and Gould & Eberhardt; cold saws from the Newton Machine Tool Works; nut and bolt forging machines from the Acme Machinery Co.; thread cutters from Pratt & Whitney; manufacturing automatics from Potter & Johnston; boring machines from the Binsse Machine Co., and various tool specialties of Brown & Sharpe manufacture.

As mentioned, the method of driving is through shafting, from only one motor for each long row of machines—an arrangement which is carried out for each section. That this system has some advantages cannot be doubted. The motors are sturdy four-pole machines for direct current, and of surprisingly small size for the service. Owing, however, to the skill with which the work is planned and distributed, the various operations during the day are so evenly apportioned that the load is very steady, being about as near to a continuous manufacturing process as can be attained in machine shop practice. The motors, also, are so situated that they can be carefully watched and any signs of trouble at once given attention. Under less favorable conditions individual motor drive for a part of the system would probably give more satisfactory results, but in the Reinecker shops the method used could hardly be bettered.

Returning to the view of the large assembling and erecting shop, Fig. 1, the reader will note the excellent arrangements for handling material afforded there: the ample head-room, the large traveling electric cranes, and the swinging-arm cranes with chain hoists at each side. There is one of these for every pillar. It is plainly marked with its capacity and bears a number that serves to designate the exact place at which a machine tool part is to be delivered for erection. The shop floors are of cement, all on one level, and light material is quickly moved about on hand trucks, as in the case of the motor shown in the middle foreground of Fig. 1.

The tools used on the shop machines are kept in classified cabinets, and at each machinist's station there are suitable places for keeping the tools and other property of the firm which he has on hand at the time. Frequently they are to be found in the pedestals of the machines, themselves, good examples of which are to be seen in Fig. 3. These tool cupboards serve a double purpose, for the pedestals, being nearly hollow, carry the beds of machines in such a manner as to permit expansion and contraction, due to temperature changes, to take place without straining or buckling. For handling heavy parts, etc., the machine tools are served by chain hoists running on I-beams parallel with each row. There is good natural lighting from skylights and windows; also electric illumination, when needed, by arc lights and incandescent lamps suspended over the tools in the manner now common to good shop practice the world over. The shops are heated

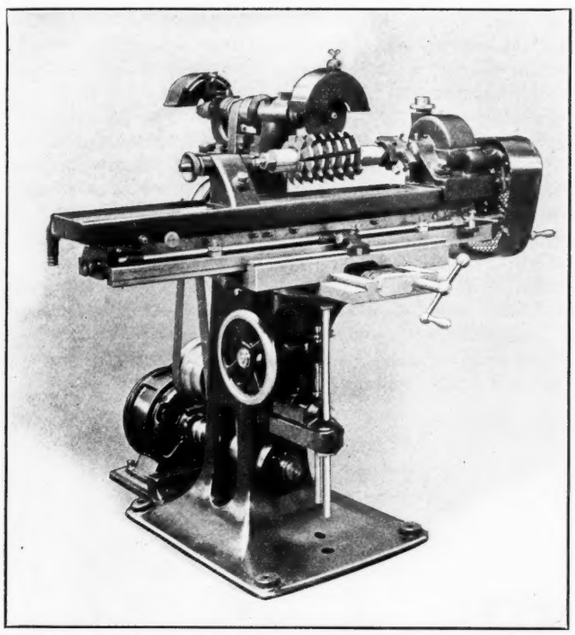


Fig. 19. Tool Grinder with Spiral Dividing Head, electrically driven

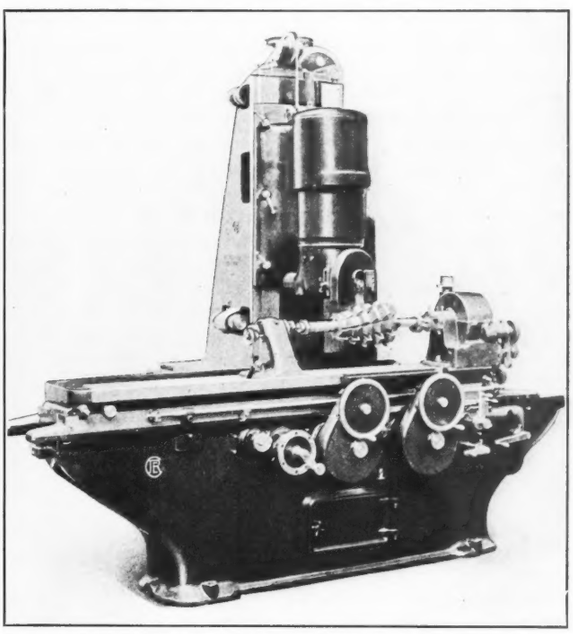


Fig. 20. Automatic Tool Grinder set for Sharpening Worm Hobs

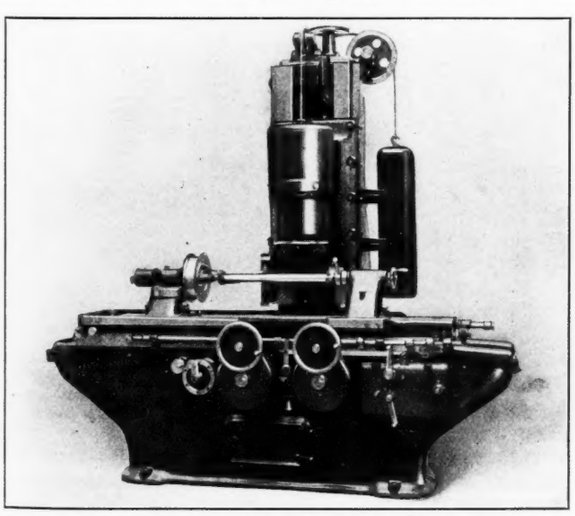


Fig. 21. Tool Grinder shown in Fig. 20, set for Cylindrical Grinding

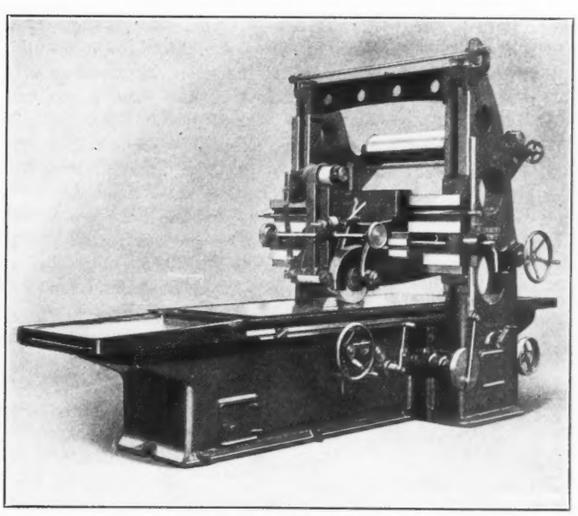


Fig. 22. Surface Grinding Machine

by steam sent through fluted pipe radiators, as illustrated in Figs. 3 and 4.

For machine cleanliness and the protection of the operatives, all moving parts extraneous to the work are enclosed by removable panels, and exposed gears are protected, where dangerous, by light rod or wire-screen guards as in Figs. 4 and 14. This protection, however, is not carried to quite the extent that the writer has observed in other shops, both at home and abroad.

There is a large department devoted to patternmaking, with good machine equipment and also a great deal of careful hand-work. If the plant has an iron foundry connected with it, the writer does not recall seeing it and is under the impression that iron and steel castings are purchased, which is usually the economical thing to do. A small brass foundry, however, provides what the plant needs in this line. The smith-shop, containing a fair complement of hammers, hand forges, etc., has been enlarged and a steam-hydraulic forging press added. The furnaces and other equipment are about what one would expect to see. A modern electric power and compressor plant, with engine-driven generators for direct current, water-tube boilers, automatic stokers, etc., helps to make the works "self-contained;" and there are the usual steam lines to the hammers, heating system, etc.

The facilities for tool hardening and tempering are about what one would find in a first-class English, American or Canadian establishment; but rather more space and better space is devoted to the tool making and sharpening department than is usual elsewhere. This is a large area extending along one side of the rows of heavy lathes and having windows all the way. Julius Eduard Reinecker, the founder of the business, began life as a toolmaker, and especial attention has always been given to this branch of the work. The first machine tools built, beginning in 1885, were milling cutter- and tool grinders, and four years later the manufacture of machines for making milling cutters, taps, twist drills, etc., was commenced. From this, the business naturally developed; and *its success is largely to be ascribed to the fact that the study of machine design was preceded by and coordinate with a thorough knowledge of the tools used with the machines.*

Strict discipline is maintained among the workmen, who number upward of 2000. They check in and out on time clocks, which are grouped near the stations occupied. Every possible provision is made for the comfort and convenience of the employes. Individual numbered lockers, lavatories and closets are at their disposal, and each has a numbered chest, with lock and key, as shown in Fig. 12, for his personal belongings. At the windows there are curtains to keep out the sunshine when too warm or bright. During the noon and the morning and afternoon rest periods, coffee is served from a stand in the center of each shop. There are also various features of welfare work along lines somewhat similar to those described by the writer in the article on the "Metal Working Industries of Düsseldorf" in the November issue of MACHINERY.

The apprenticeship system is given particularly careful consideration, being very much on the order of the one at the Ludwig Loewe works in Berlin, mentioned by the writer in MACHINERY, engineering edition, for September. The same loyalty to the employers who gave them their training—whether in service at the Reinecker works or as journeymen elsewhere—also appears to characterize the machinists educated here, as the writer learned from conversations in various parts of Europe. There is, in the Reinecker works, a special department devoted to various features of apprenticeship instruction, completely equipped, and arranged at the side of one of the shops, next to the windows, where there is good light. Provision is also made for the usual continuation school course.

In each of the well-appointed business offices, as one enters, is to be seen a large globe of the world, showing the marks of constant usage. This is a good illustration of the cosmopolitan character of the firm's trade.

In conclusion, the writer would say that he found Reinecker tools in the best equipped shops, not only of Germany but also of Austro-Hungary, Italy, Switzerland, Holland, Belgium and France. In England and other European countries they also have a large sale. For automobile, locomotive and turbine building, and for all work involving the production of milled parts and gears, they are particularly prized. In comparison with American tools, the Reinecker machines offer as strong competition as any manufactured on the continent of Europe. The present senior member of the firm is well acquainted with the work of the best shops in the United States, having spent a full year here on one occasion; and the firm has taken every possible opportunity of studying the best of contemporary machine design, in all manufacturing countries. The reasons for its success, therefore, are not difficult to find.

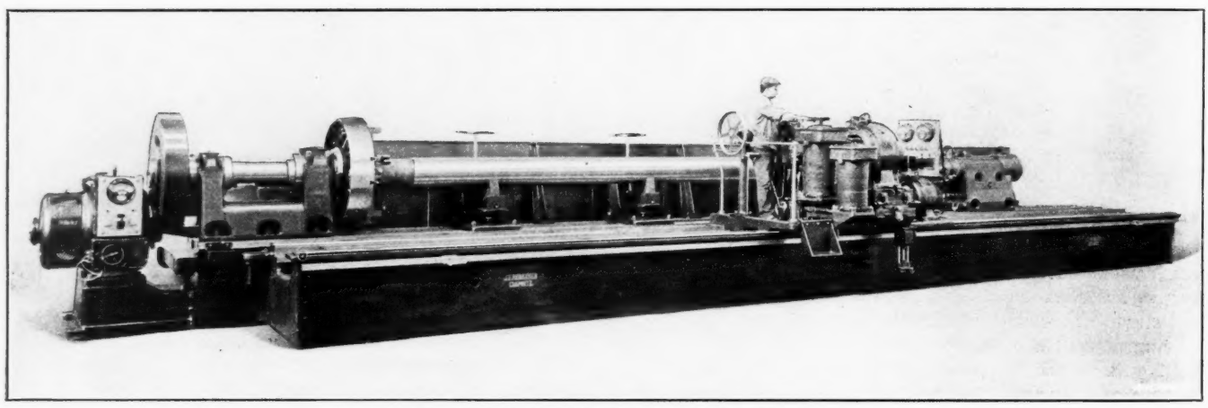


Fig. 23. Large Automatic Cylindrical Grinding Machine

* * *

## COMPLAINTS WITHOUT INVESTIGATION

Many complaints are made to makers of small tools when the failures are in no way the fault of the makers. In investigating some of the cases a great deal of diplomacy is necessary on the part of the maker to avoid "getting in bad" with a superintendent or foreman who has made the report without careful personal examination of the conditions. If a workman breaks an expensive high-speed twist drill by carelessness, his impulse, if not too honest, is to report it as being due to a fault in the steel. Those in charge should, for the sake of prestige with those who know small tools and their capabilities, carefully examine all complaints and determine to their own satisfaction the causes of the failures. They will often discover grave abuses and save their concerns heavy losses, to say nothing of imposing additional losses on small tool makers through traveling expenses and replacements.

* * *

Experiments undertaken for measuring the temperature on the inner surface of the cylinder of a small gas engine have shown that the temperature is about 465 degrees F., and that the variation from cycle to cycle is usually less than 18 degrees F. The steady conditions of low temperature at the wall surface were caused by the jacket water, while very great changes of heat take place at a very short distance from the walls.

# HERRINGBONE GEARS*

## WITH SPECIAL REFERENCE TO THE WUEST SYSTEM

That the helical principle in toothed gearing is ideal from a theoretical point of view is well known. From a practical standpoint herringbone gears have been less satisfactory than straight-cut spur gears because, until recently, no method was devised for producing them with the requisite speed and accuracy. Within the last six years, however, a method has been developed, in England, to a high degree of perfection. Herringbone gears made by this method are called Wuest gears, after the inventor.

The distinction between these gears and those of the ordinary herringbone type is that the teeth of the former, instead of joining at a common apex at the center of the face, are stepped half the pitch apart and do not meet at all. This arrangement of the teeth does not affect the action of the gears, but it facilitates their commercial production. The utilization of power constantly calls for means to transmit rotary motion from one axis to another. While there are many ways in which such transmissions may be produced, the merits of all of them must be judged from the following standards: (*a*) reliability and freedom from wear and tear; (*b*) economy of outlay; (*c*) mechanical efficiency; (*d*) compactness; (*e*) evenness of transmission, absence of shock, jar or vibration; (*f*) absence of noise.

### Action of Spur Gearing

The aim of all designers of gearing is to transmit rotary motion from one axis to another in a perfectly even manner without variation of angular velocity. Let us consider the

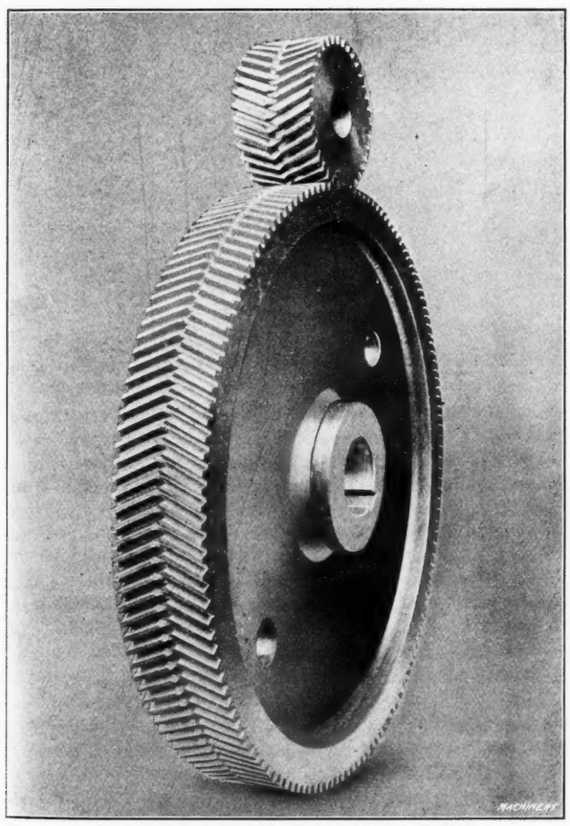


Fig. 1. Typical Wuest Herringbone Gear and Pinion

action of a straight spur pinion driving a gear. There are three distinct phases of engagement:

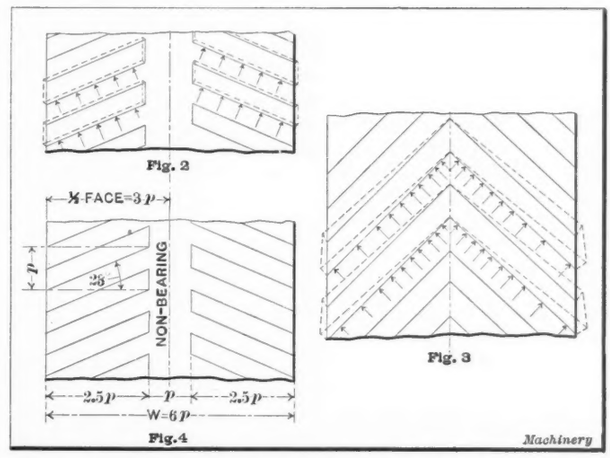
First phase: The root of the pinion tooth engages the point of the gear tooth.

Second phase: The teeth are engaged near the pitch line.

Third phase: The point of the pinion tooth engages the root of the gear tooth.

Let us assume that the teeth are accurately cut to involute form, so that if the pinion moves with even angular velocity it will produce corresponding evenness of motion in the gear; and also that the pinion has sufficient teeth to allow the engagement of successive teeth to overlap. At the beginning of the first phase, while the load is carried near the point of the gear tooth, that tooth is subjected to a maximum bending stress along its whole length. The portion of the pinion tooth near the root is sliding over the outer portion of the gear tooth; that is to say, two metallic surfaces of small area are sliding under heavy compression.

The action during the second phase more nearly approaches ideal conditions. The teeth are engaged near their respective pitch lines and very little sliding takes place. During the third and final phase, the pinion tooth is subjected to a




Figs. 2 to 4. Diagrams showing Tooth Pressures and Angle Necessary for Continuity of Action

maximum bending stress, while the tooth surfaces again slide over each other, this time with the outer portion of the pinion tooth engaging the gear tooth near its root. The point to be noted is that while those portions of the mating teeth which are near the pitch lines transmit the load with rolling contact, those which are more remote have to transmit the same load with sliding contact. The inevitable result is that the points and roots of all the teeth tend to wear away more rapidly than the portions near the pitch lines.

It may be suggested that the sliding action can be eliminated by shortening the teeth so that they engage only the phase of rolling contact. This has been tried with a certain measure of success in the stub-toothed gear, but it cannot be carried far enough without curtailing the arc of contact so that continuity of engagement is lost.

### Action of Herringbone Gears

Herringbone gears completely overcome all these difficulties, but only when they are accurately cut. If we take two exactly similar pinions with straight teeth and place them side by side on one shaft, with the teeth of one pinion set opposite the spaces of the other, then we have what is known as a stepped-tooth pinion. If this pinion is meshed with a composite gear made up in a similar manner, the action is modified so that there are always two phases of engagement taking place simultaneously. Such gears are commonly used for rolling mill work, because they stand up to heavy shocks better than the plain type. Still better action can be secured by assembling a number of narrow pinions with the last of the series one pitch in advance of the first and the others advanced by equal angular increments. As a practical proposition, however, gears made on these lines would be costly and difficult to produce.

The helical gear is the logical outcome of the stepped gear carried to its limit, and built up from infinitely thin laminations. Since the steps have merged into a helix, there must be a normal component of the tangential pressure on the teeth, producing end thrust on the shafts. To obviate end thrust, the helical teeth are made right-hand on one side and left-hand on the other. (See Fig. 1.) Such gears, with double helical teeth, are known as herringbone gears.

The fundamental principle of the action of herringbone teeth lies in the circumstance that *all phases of engagement take*

* Abstract of paper by Percy C. Day, Milwaukee, Wis., read before the meeting of the American Society of Mechanical Engineers, under the auspices of the sub-committee on machine shop practice, at New York, December 5-8, 1911.

*place simultaneously.* This holds good for every position of pinion and gear, provided only that the relationship between pitch, face width, and spiral angle is such as will insure a complete overlap of engagement. Since all phases of engagement occur together, it follows that the load is partly carried by tooth surfaces in sliding contact and partly by surfaces in rolling contact. The result is curious and interesting.

Those portions of the teeth farthest from the pitch line, which engage with sliding action, tend to wear away more rapidly than the portions nearest the pitch line. But the pitch line portion is always carrying part of the load, and the effect of wear on the ends of the teeth merely tends to throw more load on the center portions; in other words *there is a tendency to concentrate the load near the pitch lines.* The ends of the teeth, instead of wearing away to an ever-increasing extent from their original involute form, are relieved of some of the load from the moment that wear commences to take place. As soon as the load on these ends has been partially relieved and transferred to the middle portion, the wear becomes equalized all over the teeth and they do not tend to distort further from their original shape.

As the teeth keep their involute form, motion is transmitted from pinion to gear in an even manner, without jar, shock, or vibration. Although herringbone teeth may be intrinsically stronger than straight teeth, the elimination of shock renders them capable of transmitting heavier loads. Since all phases of engagement occur simultaneously, the transference of the load from one pinion tooth to the next takes place gradually instead of suddenly. This is the second principle of herringbone gearing, and may be termed *continuity of action.* In straight gears the continuity of action is a function of the number of teeth in the pinion. In herringbone gears continuity depends on the relationship between the face width and the number of teeth in the pinion. Pinions with as few as five teeth have been used with success by merely increasing the face width to suit such extreme conditions. This feature, which is peculiar to herringbone gears, has made practical the adoption of extremely high ratios of reduction hitherto considered impossible.

The third principle of herringbone gearing is that the bending stress on the teeth does not fluctuate from maximum to minimum as in straight gears, but remains always near the mean value. This feature is of special importance in rolling-mill driving and work of a similar nature.

To summarize the foregoing statements: The action of herringbone gears is continuous and smooth; there is no shock

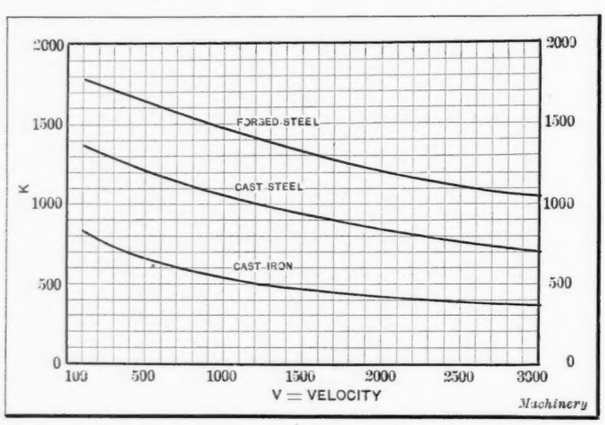



Fig. 5. Shearing Stress with Relation to Pitch Line Velocity

of transference from tooth to tooth; the teeth do not wear out of shape; the bending action of the load on the teeth is less than with straight gearing and does not fluctuate to anything like the same extent; the gears work silently and without vibration; back-lash is absent; friction and mechanical losses are reduced to a minimum; herringbone gears can be used for higher ratios and greater velocities than any other kind.

### The Production of Herringbone Gears

Herringbone gears may be produced in a variety of ways. Until a few years ago all gears of this type were molded. The limitations of molded gearing are analogous to those which would be experienced if a journal were set to run in a molded bearing. Just as the bearing would touch the shaft only in spots, so molded gears utterly fail to give the intimate contact all along the teeth which is necessary to secure true helical gear action. The herringbone gear must have cut teeth if its advantages are to be realized.

Cut herringbone gears may be broadly divided into two classes, two-piece and one-piece gears. The difficulty in the way of cutting double helical teeth in a single blank gave rise to the two-piece variety. The same methods of cutting may be used for both kinds. The disadvantages of the two-piece type are obvious. There is the expense of two complete gears, the difficulty of assembling the gears so they are in accurate

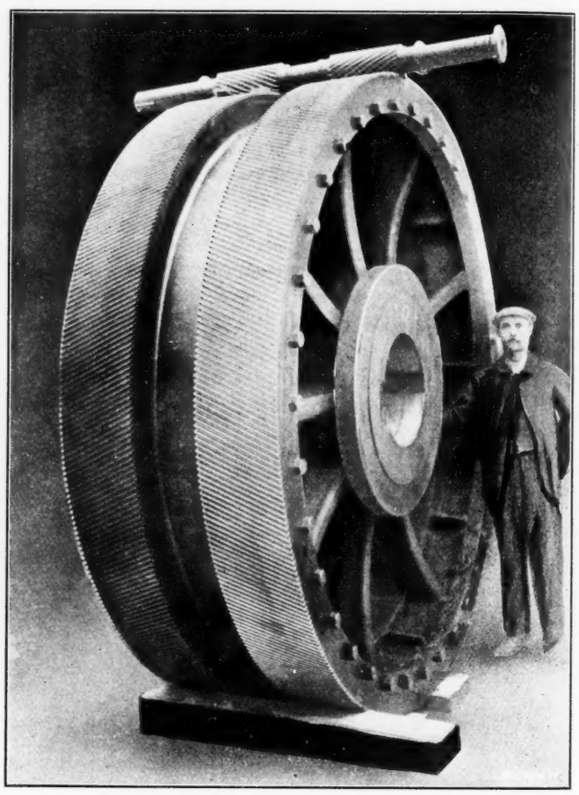


Fig. 6. Gear and Pinion for 500 H.P. Marine Turbine

register with each other, and the necessity for very thorough fastenings if they are to perform hard service without getting out of register. High ratios are not within the scope of the built-up gear, because the pinions must be assembled on a separate shaft and the pitch line must be far enough from the surface of the shaft to allow room for the necessary bolts or rivets used in fastening the two portions together. The one-piece pinion, however, may be cut solid with its shaft, so that its pitch diameter need be but very little larger than the latter.

The methods of cutting helical gears may be divided into four classes: (*a*) milling by formed disk cutters; (*b*) milling by end-mills; (*c*) generating by shaping or planing methods; (*d*) generating by hobs.

Milling by formed disk cutters is unsatisfactory, because, in addition to the usual errors of step-by-step division, there is the difficulty of making the cutters to the *normal* tooth shape with sufficient accuracy. This difficulty is increased by reason of the fact that a disk cutter cannot cut its own shape in a spiral groove. Worst of all, two different cutters must be used for a gear and pinion.

The use of end-mills is open to all the objections to disk cutters, with the single exception that the cutter does leave a fair approximation to its own shape in the groove which it cuts; but the end-mill has a host of disadvantages peculiar to itself which render it even less efficient than the disk cutter for general work. In the first place, it is a small tool with very little wearing surface and no capacity for dissipating the heat generated at its cutting edges. The great variation in diameter between point and base renders it difficult to arrive

at a cutting speed which will satisfy the conditions at both ends of the cut. The mills quickly become clogged with cuttings, overheat and burn. To complete one fair-sized gear by the end-mill process requires quite a number of cutters. This not only makes the expense heavy, but must necessarily result in an inaccurate gear.

End-milled herringbone gears are usually made in one piece with the teeth joined at the center. Since the cutter is shaped to the normal pitch, it follows that, in changing over from right- to left-hand helix, it leaves a thick wedge in the center of the face that must be removed by a subsequent operation. The teeth of end-milled herringbone gears do not bear over the center portion.

Generating processes of the shaping and planing type, while successful for straight-cut gears of relatively small size, are not used to any extent for large diameters or heavy pitches. The reason for this may be found in the nature of the processes. The gear blank is required to make a quick angular movement after each stroke of the cutting tool and to come to rest again before the next stroke. Such methods are difficult to apply to large gears on account of the inertia of the gear blank and its support and the consequent difficulties of controlling the short intermittent movements. These difficulties

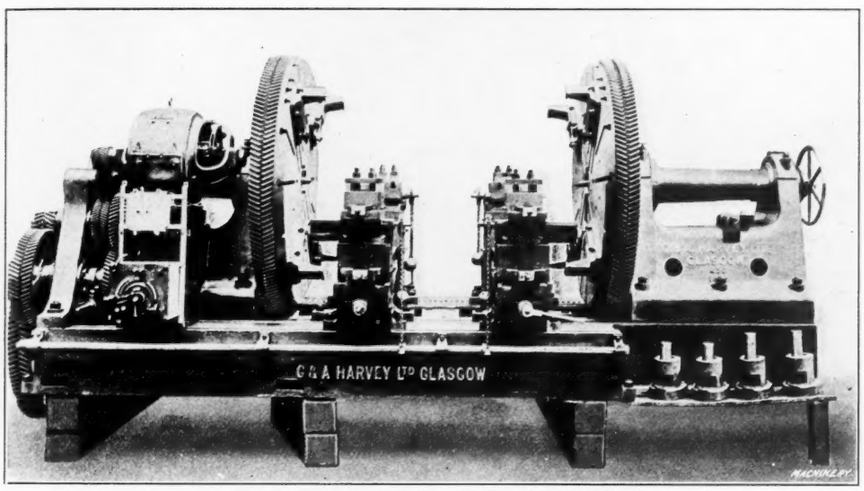



Fig. 7. Tire-turning Lathe with Herringbone Gears

are much increased when such methods are applied to cutting helical teeth because the blank must make definite and rapid angular movements during each stroke in addition to the motion between strokes.

The hobbing process as applied to straight-cut gears has proved so successful as to arouse adverse criticism from those who are interested in other methods of gear production. The shape of the teeth is generated from spiral hobs, the threads of which are cut to a plain rack section. One hob will cut any gear or pinion of one pitch. This feature alone eliminates many errors which are characteristic of gears produced by milling methods. The hob revolves continuously while cutting, as does the gear blank. The feed is also continuous. There are no cutting and return strokes, no intermittent starting and stopping of gear blanks, as in other generating processes. These features do not necessarily insure the production of accurate gears, but they offer greater facilities to the designer for the achievement of the desired result.

### Wuest Herringbone Gears

It has been explained that the teeth of the Wuest gears are so designed that those on the right- and left-hand sides of the gears are stepped half a space apart and do not meet at a common apex at the center of the face, as in the usual type of herringbone gear. It has often been argued that the ordinary herringbone tooth is stronger than the Wuest tooth, because the latter lacks the support given by the junction of the teeth at the center. This argument would be sound if gear teeth were ever stressed to anywhere near their breaking point. But it has been found in practice that considerations of wear so far outweigh those of mere breaking strength that a gear which is designed to give reasonable service will carry anywhere from ten to twenty times the working load without fracture. A point of vastly greater importance is that the stepped form will wear more evenly under extreme loads than the ordinary type. The reason for this is shown in Figs. 2 and 3. The resultant tooth pressure is always normal to the teeth and tends to bend them apart. The stepped form offers a uniform resistance along its whole length, carrying the load from end to end (Fig. 2). The teeth of ordinary herringbone gears tend to separate more at the sides than near the supported center, causing the load to be concentrated toward the center (Fig. 3).

The standards which have been adopted for Wuest gears are the result of experience gained in Europe during the last six years. The spiral angle of the teeth is about 23 degrees with the axis. Since the nature of the action eliminates shock, it follows that the pitch required for given conditions will be much finer than would be chosen for spur gears. On the other hand, the face width will not be less, because there is as much necessity for wearing surface with one kind of tooth as with the other. Spur gears are usually made with a face width equal to three or four times the pitch. Herringbone gears may conveniently have a face width equal to six times the pitch, not because the width of this type need actually be greater, but by reason of the pitch being proportionately less.

Starting with a width equal to six times the pitch, and allowing one times the pitch as the non-bearing portion in the center, there remains two and one-half times the pitch available for the teeth on each side. To insure continuity of engagement under all ordinary conditions, each tooth is inclined so as to cover an advance of one times the pitch within its length. The angle of 23 degrees satisfies this requirement (see Fig. 4).

The pressure angle which has been adopted for standard gears is 20 degrees. The teeth are shorter than the usual standards. The high ratios used with these gears call for an average pinion diameter which is less than is used with straight spur gears for similar duty. The teeth are generated by hobs, and the short addendum combined with wide angle gives satisfactory tooth shapes, without undercutting of teeth, for small pinions.

The dimensions proposed for an interchangeable system for these gears are as follows:

Tooth shape ..... Involute
Pressure angle ..... 20 degrees
Spiral angle ..... 23 degrees

$$\text{Pitch diameter (20 teeth and over)} = \frac{\text{Number of teeth}}{\text{D.P.}}$$

$$\text{Blank diameter (20 teeth and over)} = \frac{\text{Number of teeth} + 1.6}{\text{D.P.}}$$

$$\text{Pitch diameter (under 20 teeth)} = \frac{0.95 \times \text{Number of teeth} + 1}{\text{D.P.}}$$

$$\text{Blank diameter (under 20 teeth)} = \frac{0.95 \times \text{No. of teeth} + 2.6}{\text{D.P.}}$$

$$\text{Addendum} \ldots\ldots \frac{0.8}{\text{D.P.}}$$

$$\text{Dedendum} \ldots\ldots \frac{1.0}{\text{D.P.}}$$

$$\text{Full depth} \ldots\ldots \frac{1.8}{\text{D.P.}}$$

$$\text{Working depth} \ldots\ldots \frac{1.6}{\text{D.P.}}$$

Standard face width for gears with pinions of not less than 25 teeth, 6 times circular pitch; face widths for high-ratio gears with small pinions, 6 to 12 times circular pitch.

When a pinion of less than 20 teeth is used with a standard

gear, the center distance must be slightly increased to suit the enlargement of the pinion. If it is desired to keep the center distance to the standard dimensions, the gear diameter may be reduced by the amount of the enlargement given to the pinion. For example: If a pinion of 10 teeth, 5 diametral pitch is to mesh with a gear of 90 teeth at 10-inch centers,

$$\text{Pitch diameter of pinion} = \frac{0.95 \times 10 + 1}{5} = 2.1 \text{ inches.}$$

$$\text{Enlargement over standard pinion} = 0.1 \text{ inch.}$$

$$\text{Pitch diameter of standard gear} = \frac{90}{5} = 18.0 \text{ inches.}$$

$$\text{Reduced pitch diameter of gear} = 18.0 - 0.1 = 17.9 \text{ inches.}$$

$$\text{Center distance} = \frac{17.9 + 2.1}{2} = 10 \text{ inches.}$$

The important factor in determining the proportions of the teeth is the relationship between pitch line velocity and the permissible specific tooth pressure; in other words, the total tooth pressure divided by the area of all the available simultaneous contact along the teeth. Theoretically, this contact has no area since it should consist of lines without breadth. Actually, an area exists, due to the elastic compression of the teeth in contact, in a similar way in which an area of contact exists between a car wheel and a rail. The area of contact is indeterminate, but the specific tooth pressure is proportional to the driving stress on the teeth.

In order to obtain a simple rule for finding the proper dimensions, the results of experience in the matter of safe working loads under given conditions have been reduced to a relationship between pitch line velocity and the shearing stress on the pitch line thickness of an imaginary straight tooth, assuming only one tooth in engagement at a time. The shearing stress is a measure of the specific tooth pressure, and the relationship referred to affords a convenient means of arriving at reliable dimensions. The curves, Fig. 5, give values of shearing stress $K$ in pounds per square inch on pitch line section of an imaginary single tooth for corresponding pitch line velocities $V$ in feet per minute. The values are entirely empirical, but they are based on the results of extended experience, and lead to dimensions which are safe and reliable. Different curves are given for different materials, and it is necessary to use that curve which corresponds to the lowest grade material of the combination. The dimensions of gears can be derived from the curves in the following manner:

H.P. = brake horsepower transmitted,
$N$ = revolutions per minute,
$D$ = pitch circle diameter, inches,
$p$ = circular pitch in inches (use nearest diametral pitch),
$W$ = total width of face, inches,
$V$ = pitch line velocity, feet per minute,
$P$ = total tooth pressure at pitch line, pounds,
$K$ = stress factor (from curve).

Then

$$V = \frac{\pi D N}{12} \qquad P = \frac{\text{H.P.} \times 33{,}000}{V} \qquad P = \frac{p W K}{2}$$

$$P = 3 p^2 K \left\{ \begin{array}{l} \text{in normal gears of moderate ratio, and face} \\ \text{width equivalent to six times the circ. pitch} \end{array} \right.$$

$$p = \sqrt{\frac{P}{3K}}$$

For high ratio gears take $W = Rp$ ($R$ = ratio) up to maximum of $W = 10p$.

$$p = \sqrt{\frac{2.5 P}{RK}}$$

In normal gears it is safe to aim at pitch line velocities between 1000 and 2000 feet per minute, with 1500 feet as a fair average. If the pinion is to be fixed to a motor shaft without external support, the diameter must be greater than when it can be supported on both sides. Cast iron is preferable to cast steel for gears of large diameters and moderate power, but the latter will be found more economical for high tooth pressures. Pinions are usually made from steel forgings of 0.40 to 0.50 per cent carbon. Soft pinions should never be used for herringbone gears.

There are two special cases where the ordinary methods of calculation should not be used. Rolling-mill gears are subjected to stresses which are so far in excess of the average working load that it is necessary to consider carefully the strength of the teeth in regard to possible overloads. Extra high velocity gears, such as are used for steam turbines, require additional wearing surface and are characterized by extreme width of face combined with abnormally fine pitch.

### Application to Steam Turbines

Direct-connected steam turbines for marine propulsion have been only partially successful in a very limited field. It is only when the power required is very great and the speed of the vessel unusually high that the direct-connected turbine can be applied, and even then the application does not do full justice to either turbine or propeller, while the first cost is much higher than it need be. The use of direct-coupled turbines is confined to ocean fliers and warships. Ordinary vessels of commerce cannot be adapted to turbine power in this form. Mr. Parsons attacked the problem of applying the turbine to an ordinary freight steamer of moderate power. To this end he purchased the S. S. Vespasian, a modern tramp with triple-expansion engines of about 1000 H.P. and a speed of 11 knots with propeller running at 75 R.P.M. As a preliminary to the installation of geared turbines on this vessel, the original engines were overhauled, and a series of coal consumption trials made under regular sea-going conditions.

The engines were then removed and for them were substituted a pair of steam turbines connected to the propeller by the herringbone gears illustrated in Fig. 6. Each turbine develops about 500 H.P. at 1500 R.P.M. The propeller runs at the original speed of 75 R.P.M. Each turbine is coupled to a herringbone pinion with teeth cut solid on a shaft of soft-grade chrome-nickel steel. The two pinions mesh with rolled-steel gear rings mounted on a cast-iron spider which is keyed to the propeller shaft. The whole gear system is enclosed in a case, and the teeth are kept lubricated by oil jets. The great width of the pinions in proportion to their diameter made it necessary to provide room for bearings between the right- and left-hand teeth. The proportions of this remarkable gear unit are as follows: Pinions, 20 teeth; gear, 398 teeth, 4 diametral pitch; teeth of involute form, 20-degree pressure angle, 23-degree spiral angle; over-all face width, 34 inches, including 10 inches space for bearing; actual face width, 24 inches; ratio of reduction, 19.9 to 1. This gear has now been running regular voyages for more than a year and has covered over 20,000 miles. The results have been interesting and satisfactory. The efficiency of the gear is fully 98 per cent, including the losses in the bearings on the gear case. The geared turbine shows a sustained all-around saving in fuel consumption of more than 25 per cent over the original engines. The wear on the teeth is negligible after 20,000 miles, being only 0.002 inch at the pitch lines of the pinions.

### Herringbone Gears for Machine Tools

The field for accurate herringbone gears in connection with machine tool driving is too extended to be considered in detail. For individual motor drives this gear gives a positive transmission which is free from vibration and less noisy than so-called silent chains or rawhide pinions, while there is no trouble from slipping belts or slack chains; but the real advantage of these gears lies in the better finish that can be obtained when they are used for the entire main transmission, and in the higher output combined with reduced maintenance which they give to heavy machine tools. Chatter is eliminated. Even the speeding up to the wheels of grinding machines has been successfully accomplished. Reversing gears for heavy planers are a revelation to those familiar only with the ordinary spur drive.

* * *

A German scientist, Dr. R. Wegener, states in the *Chemische Zeitung* that studies of the outer layers of the earth's atmosphere have led him to the conclusion that in these outer layers there exists a hitherto unknown element lighter than hydrogen.

# TOOLS AND METHODS OF THE GOODMAN MFG. CO.

By EDWARD K. HAMMOND*

Although attractive grounds have no direct bearing upon the operation of a plant, it cannot be denied that the attention given to the approach to a factory must tend to create higher standards among the employes in the shops; and as one walks up the path to the entrance of the Goodman Mfg. Co.'s factory, observing the neatly cut lawn, the beds of flowers, and the vine covered building, remembering meanwhile that one is in the heart of the manufacturing district of Chicago, one is bound to feel that this care for outward

Fig. 1. General View of the Laying-out Department

appearances is an indication of the attention given to the work in the shops. The Goodman Mfg. Co. is engaged in building electric coal mining machinery, and it is the purpose of this article to describe a few of the shop and tool-room methods which are in vogue in its shops.

Passing through the offices and drafting-rooms at the front of the building, one arrives at the factory office, from which the operation of the plant is directed. One of the noticeable features of the equipment of this office is a bulletin board upon which all orders are recorded in the order in which they are received. The different types of machines built by the company are designated by numbers, and the bulletin board is laid out with spaces for the order number, the name of the company for which the work is being done, the number which indicates the type of machine, and the date upon which delivery is required. Upon receiving an order for the construction of a given machine, the foreman comes to the shop office and consults the bulletin board in order to ascertain the date upon which delivery is required. He then issues his orders accordingly, work on certain orders being delayed, if necessary, in order to complete machines which are required for delivery at an earlier date. This system of recording each order also enables the foreman to use parts from a similar machine, which is not in a particular hurry, if he finds that there is a shortage in the store-room on parts that are required to fill a rush order. Bills of material are used which show all of the material that is required for the construction of each type of machine.

A somewhat unusual feature in the Goodman factory is that of having all of the work laid out in a separate department, instead of having it done by the individual mechanics. A general view of this laying-out department is shown in Fig. 1, from which it will be seen that high-class surface plates are used. The men working in this department become so expert through their wide experience in this work that the highest precision is attained.

Each drawing used by the Goodman Mfg. Co. shows but a single part. In issuing drawings to the workmen, a check board is used that has a hook on it under each man's number. When a man takes out a drawing, a check bearing its number is placed on his hook and this check is removed when the drawing is returned. This system makes it possible to immediately locate any drawing that is out in the shops in case it is required; the method also eliminates the loss of drawings, as a man is held responsible for a drawing that is checked against his number. The drawings are filed in cabinets, when not in use.

### The Tool-room

The old-fashioned tool-room system of having one man start a piece of work and follow it through to completion, meanwhile working with great deliberation, owing to the impression that slow work and accurate work are necessarily akin to each other, has been eliminated as far as possible. On the contrary, the Goodman tool-room is operated practically along the lines of a modern manufacturing plant. A tool-order is issued by the tool-room foreman for each tool that is made; this order bears the tool number, a description of the tool, and the date. The different operations, such as milling, grinding, etc., are assigned to different men who work with the accuracy and rapidity acquired through specialization in given operations. When the tool is completed, the stub of the tool order is sent to the office where the tool is inventoried with all charges against it.

The finished tools are kept in cabinets which are 10 feet high, 10 feet wide, and 24 inches deep. Each of these cabinets is subdivided into sixteen units, which are again subdivided into cells of convenient size. Each cell is numbered to correspond with the number of the tool that is kept in it, and these numbers are also stamped on the tools. Some of the units are equipped with drawers in which the finer tools

Fig. 2. Boring and Facing Wheels on a Bullard Vertical Turret Lathe

are kept. The different sizes of milling cutters, hobs, and saws are carried on hooks which have the size of the tool marked above them.

When damaged tools are returned to the tool-room, they are placed on a separate shelf which is reserved for this purpose. These tools are then examined by the toolmaker who has been assigned to this work, and they are ground or redressed as required. After the tools have been restored to working condition, they are put into their respective places in the tool cabinets. This system of repairing tools does away with the loss of time caused through having men waiting for their tools to be repaired, the sight of several

* Address: 9620 Hoyne Ave., Chicago, Ill.

men waiting for their turn at a tool grinder being almost too common to require mention.

In issuing tools to the workmen, brass checks are used to keep a record of the tools that are out in the shop. These checks bear the numbers of the respective workmen, and a check is put in the place of each tool that is taken out. These checks are given back to the men when they return the tools. The tool-room foreman has a card catalogue which gives a complete account of every tool in his department.

### The Storage of Jigs and Fixtures

The jigs and fixtures used by the Goodman Mfg. Co. are stored in a separate room which is always kept locked, and

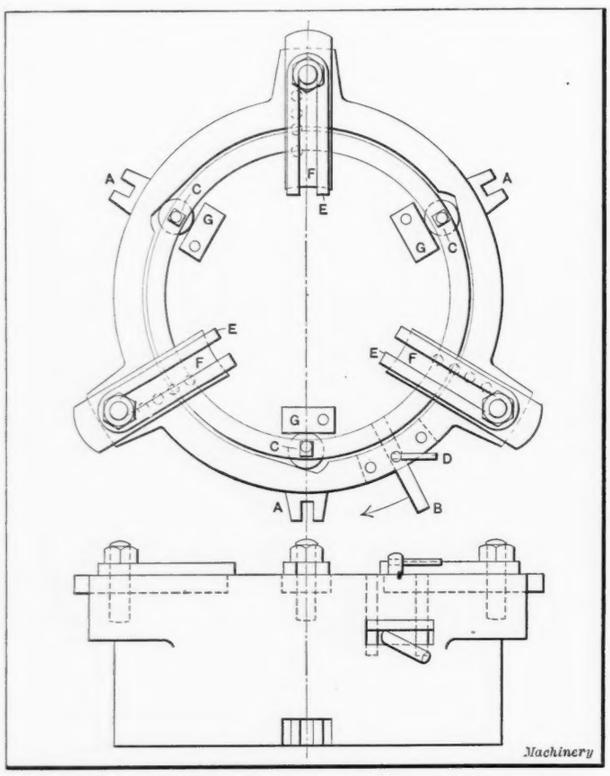



Fig. 3. Jig used in Machining Wheels on Bullard Vertical Turret Lathe

when one of the jigs or fixtures is needed, it is given out on receipt of the foreman's signed order. This room is equipped with cabinets that are subdivided into lettered and numbered cells. Each jig or fixture is stamped with the cell letter and number, tool number, drawing number, and mark number of the part on which it is used. A short description of the jig is also included. Thus one jig is stamped: "A-13, T-1376, Drawing-15,437, Mark 15,437, Jig Used for Milling Chain Straps." This gives a complete identification of the tool, showing the cell in which it is kept, the number of the tool, the drawing from which it was made, the part which is manufactured on it, and the character of the work for which it is used. This complete identification makes it impossible for any confusion to occur.

On those jigs and fixtures where the work is held in a recess, a system known as the "three piece jig" has been adopted. This consists of making the ends and one side of the jig in one piece; a piece of angle stock is then used for the other side and the bottom, while the top is attached to meet the requirements of the jig in question. This method enables the jigs to be made far cheaper than if the recess were contained in a single piece of metal, which is the practice in some shops.

In looking over the jigs and fixtures used in this shop, so many interesting devices were brought to the writer's attention that it became a difficult matter to make a selection for description in this article. The devices described were finally chosen, not necessarily because they were the most ingenious, but because their design included ideas that can readily be adopted in other shops.

### A Jig for Boring and Facing Locomotive Wheels

A particularly good jig is used in this shop for boring and facing the hubs of electric locomotive wheels. This jig, which is the design of Mr. Theo. Colby, general machine foreman of the company, is illustrated in Figs. 2 and 3. It will be seen from Fig. 3 that the jig consists of an outer body or shell provided with three lugs *A* for bolting it to the table of the Bullard vertical turret lathe. A second shell fits loosely inside of the first one and may be rotated in relation to the body of the jig by means of lever *B*. This inner shell carries three rollers *C* which engage with inclined planes cut in the body of the jig. These rollers are carried on pins that are fitted freely in the transverse slots cut in the inner shell. A rotation of lever *B* in the direction of the arrow causes the rollers to be forced inward, through the action of the inclined planes, thus centering and chucking the wheel under the boring bar. Owing to the inclined planes, a moderate pull on lever *B* provides an ample grip on the wheel; when the jig has been tightened in this way, it can be locked by means of bolt *D* that clamps down on the lever. The grip afforded by the rollers is not, however, depended upon to furnish all of the holding power upon the work, the horseshoe clamps *E* being used to hold the wheel down to the jig.

The jig is made to carry a 16-inch wheel, and in machining work of this size, the plates *F* support the wheel on the under side of the flange, thus providing for having the journal box in proper alignment with the face of the hub. Wheels 14, 12, and 10 inches in diameter may also be machined in the same jig. When machining the smaller sizes, the rollers hold the work through the action of the auxiliary blocks *G* shown in position in Fig. 3. Different sized blocks are provided to hold the different sizes of wheels. The plates *F*

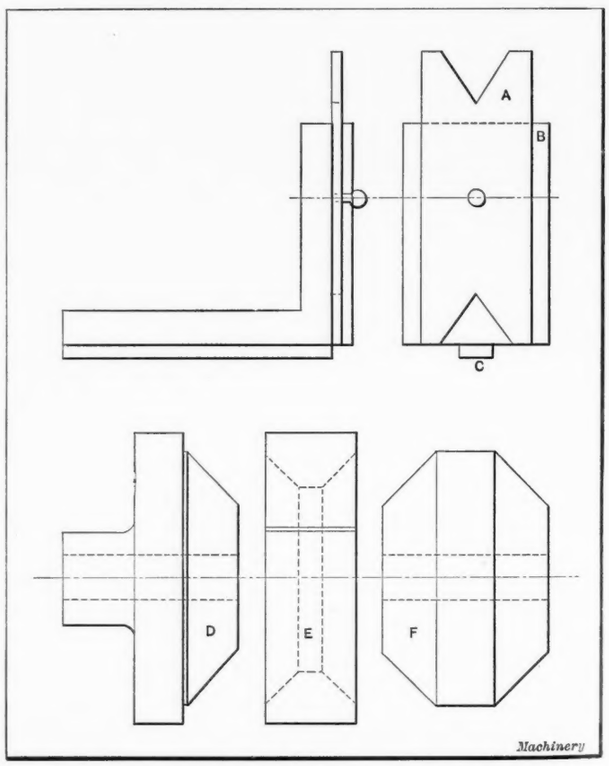



Fig. 4. Centering Device for Gear Cutter, and Fixture for Cutting Teeth in Steel Rims

are adjusted to the proper position by means of pins fitting into any of the four holes shown, each hole securing the plate in the correct position for one size of work.

The first machining operation consists of facing the hub of the wheel, this work being done by the forming tool shown in the turret of the Bullard vertical turret lathe in Fig. 2. The face of the hub is machined so that it is in alignment with the inner surface of the wheel-rim, and the gage shown lying across the wheel in Fig. 2 is used to determine when the work has been reduced to the desired point.

The Davis adjustable boring-bar shown in the illustration

is used for boring the journal box. As most mechanics know, this bar, made by the Matthews-Davis Tool Co., St. Louis, Mo., has two cutters which may be adjusted to 0.001 inch by means of a key fitting into the center of the micrometer dial shown. Before taking a cut with the Davis bar, it is the practice in this shop to take a preliminary cut with a rough boring-bar (not shown in the illustration) so that any irregularity in the castings will not damage the finer tool. A roughing cut of 0.500 inch is then taken with the first Davis boring-bar, which is followed by a finishing cut of 0.015 inch with the second bar in the turret. It has been possible, by the equipment shown, to machine one hundred wheels in a ten-hour day.

### Fixture for Cutting Gear Teeth in Steel Rims

Gears are used on some of the machines built by the Goodman company which have a steel rim, in which the teeth are cut, shrunk onto an iron center. When the teeth of these wheels become worn, new rims are supplied, to be used on the original iron centers. In cutting the teeth in these rims, the fixture shown in Fig. 4 is used to hold the work. The two parts *D* and *F* are mounted on the work arbor of a Brown & Sharpe automatic gear cutter, and the split collar *E* is held between them. The rim in which the teeth are to be cut fits on the collar *E*, and when the nuts on the arbor are tightened, the tapers cause this split collar to expand and

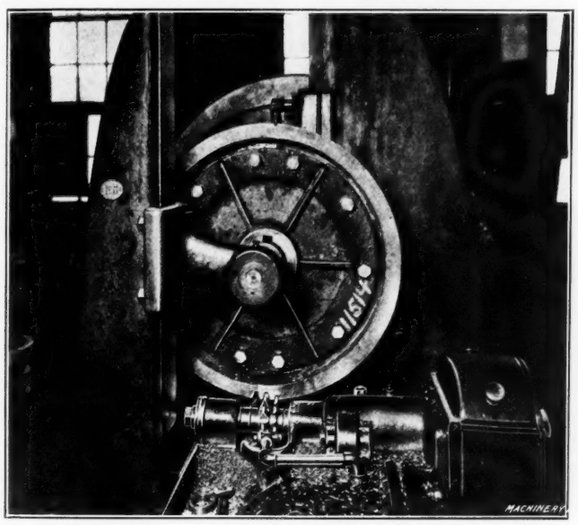


Fig. 5. Stocking Cutter used on Cutter Arbor ahead of the Gear Cutter

hold the work securely in position. This system of mounting insures having the work in proper alignment, as the tapers adjust it automatically into position.

In cutting gears on the automatic gear cutters in this shop, the method of mounting a stocking cutter on the arbor ahead of the regular gear cutter is used. The preliminary cut taken by this cutter relieves the strain on the gear cutter, and, as a result, heavier feeds may be taken without impairing the accuracy of the work. Fig. 5 illustrates a rig of this kind, a three-pitch cast-steel gear being cut. The machine is operated at the rate of 38 R.P.M. with a feed of 2¼ inches per minute.

### A Device for Centering Gear Cutters

A special centering device is used for centering the gear cutters used on milling machines. One of these centering devices is illustrated in the upper part of Fig. 4, where it will be seen that the tool is held on the table by means of a tongue fitting in the T-slot. The plate *A* is held against the shoulder *B*, and then pushed along the table until it comes into contact with the cutter. If both edges of the cutter touch the edges of the notch at the same time, it shows that the cutter is properly centered.

### A Clamp for Holding Tapered Copper Segments

In Fig. 7 a clamp is illustrated which is used for holding tapered copper segments in the milling machine vise. These segments are used in motor commutators, and the clamp is used to hold them while a slot is being sawed across their upper edges. The jaws of this clamp pivot on two cylindrical pieces which are divided at *D*, one jaw being secured to each piece. The two cylinders are held together by means of the central bolt shown in the illustration. One of the jaws is secured to the vise by means of screws entering the tapped holes *C* and the other swings free, the set-screws *F* being used to adjust it so that the work is held in a perpendicular position. When the vise is tightened, the work is held over its entire surface by these jaws.

### Cutting off Copper Contact Tips

The fixture illustrated in Fig. 8 is used for cutting off copper contact tips, such as are used on the controllers of Good-

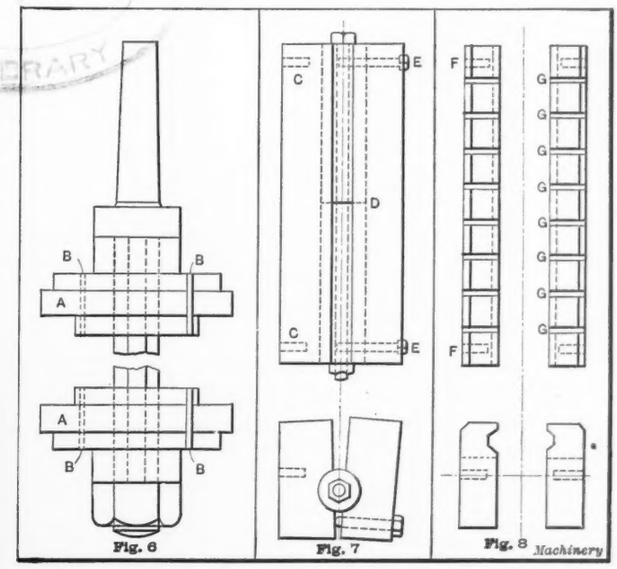



Fig. 6. Arbor used for Splitting Bushings

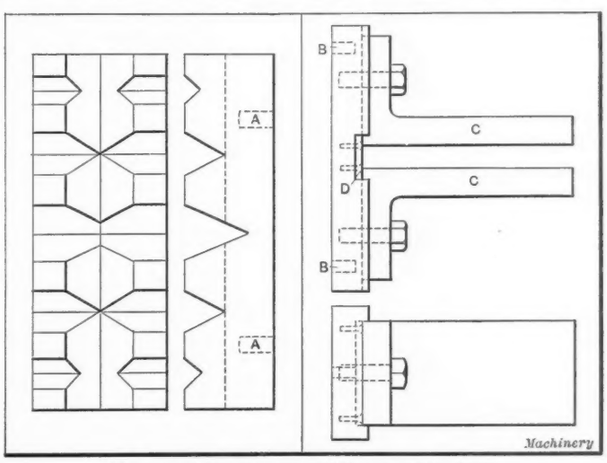
Fig. 7. Holding Tapered Segments

Fig. 8. Cutting off Commutator Tips

man electric locomotives, from the bar stock. The stock is fed up to a stop at the end of the fixture and the work is then fed up to the eight saws held on the arbor of the milling machine, the saws entering the slots *G* which are of sufficient depth to allow ample clearance below the stock. After the cut has been made, the jaws are released and the stock is then fed up to the stop ready for another cut. The fixture is secured to the vise by means of screws entering the tapped holes *F*.

### An Arbor for Splitting Bronze Bushings

A special type of arbor has been designed in this shop for use in splitting bronze bushings into exactly equal halves.




Figs. 9 and 10. Two Special Types of Vise Jaws

This fixture is illustrated in Fig. 6. The arbor has a standard taper which is held in the dividing head, and an outboard support is furnished by means of the tail-center. The bushing which is to be split is held between the collars *A* which have two slots *B* milled in them, 180 degrees apart. These slots are held in alignment by means of the key on the arbor. It will be noted from the illustration that one

pair of collars is arranged to hold two sizes of bushings by simply reversing the collars on the arbor. In using this fixture, the first cut is made and the work is then rotated 180 degrees and the second cut is taken, which parts the bushing into equal halves.

### A Special Vise Jaw

The special vise jaw shown in Fig. 9 requires little description to make its use evident to any mechanic. One of these jaws is secured in the milling machine vise by means of two screws entering the tapped holes *A* and work may be held either in the horizontal or the vertical position. The horizontal V has been found particularly useful in performing milling operations on small shafts and other similar work, while the vertical V's find application in milling such work as studs and screws.

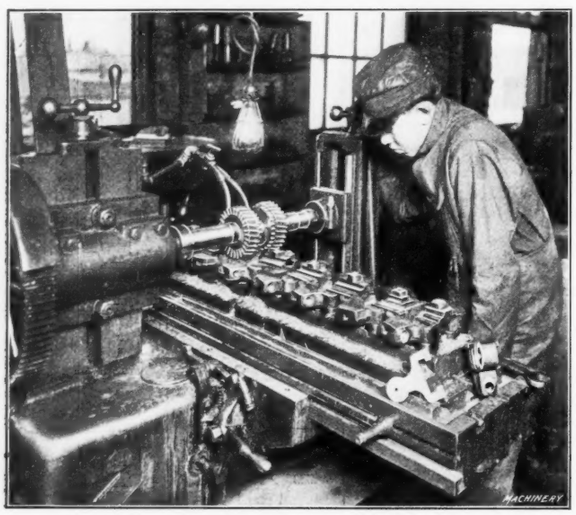


Fig. 11. Machining Chain Blocks for Coal Cutting Machines

### Method of Rounding the Ends of Keys

A special vise jaw used for holding keys while their ends are being rounded is shown in Fig. 10. This device is held in the milling machine vise by means of screws entering the holes *B*, as in the preceding case, and the jaws *C* are adjustable for different sizes of work, the jaws being held in any desired position by means of the set-screws shown in the illustration; *D* is a plate of hardened tool steel that prevents the pressure from wearing the fixture at this point.

### A Jig for Milling Coal Cutter Chain Blocks

One of the coal cutting machines built by the Goodman company has the cutting tools, used to loosen the coal, carried on a sprocket chain. The chain used for this purpose has lugs at the sides of the links which run in guides on the machine. Fig. 11 shows the method of machining these lugs to the proper size. The jig used for this purpose consists of a plate which is bolted to the table of a Lincoln milling machine. This plate has two rows of fourteen studs mounted on it, which carry fourteen chain blocks in two rows of seven each. Each block is held in the jig by means of two studs which fit into the holes in the block. The work is then held down by means of small plates which are bolted in position, each plate holding a pair of chain blocks as shown in the illustration.

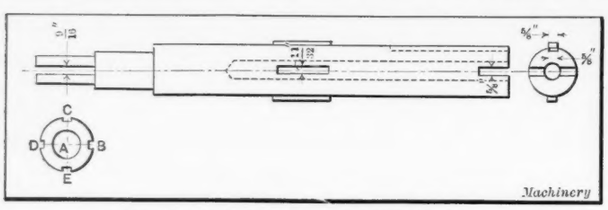



Fig. 12. Feed Shaft for Coal Cutting Machine

One of the finished blocks is shown standing on the table of the machine at the end of the jig. The machined flanges are plainly shown in this illustration, and it will be seen that the four milling cutters on the arbor of the machine finish the flanges on one side of the blocks at one traverse of the table. The jig is then opened and the work is secured with the machined sides down; a second traverse of the table then completes the machining operation. One of the gages used to test the accuracy of the finished work is also shown on the table of the machine. The chain straps which hold the blocks together are machined in a jig similar to the one just described. This jig, like the one used for the blocks, holds fourteen pieces of work at a time.

### Milling Operations on Coal Cutter Feed Shafts

The line engraving Fig. 12 illustrates the feed shaft used on coal cutting machines. Seven milling operations are performed on these shafts, and the jig illustrated in Fig. 13 enables all of these operations to be done with only one setting of the work. It will be noted from the illustration that the shaft is held in the jig in bearings; the bolted cover shown at the front of the illustration provides for securing the shaft in such a way that any rotary movement is impossible.

The shafts have a boss left on them and the cutter shown on the arbor of the machine reduces this boss to the size of the shaft. This cutter does not extend quite half way around the shaft and, as a result, more than half of the boss is left on the shaft after the first cut is made. The jig is now opened and the shaft is turned over and located at 180 degrees from its former position by means of the blocks shown at the side of the shaft on the table. These blocks fit under the shoulder made by the cut just taken, thus locating the work in the desired position. A second cut is now taken which completes the double key shown in the line drawing.

The cutter on the arbor is next replaced by a plain milling cutter of 11/32-inch face, which makes the preliminary cut for the slot in the center of the shaft. After this operation is finished on one side, the shaft is turned over as previously described, and a similar cut is taken on the other side of the shaft. These slots are then squared up at the ends by means of the slotting attachment on a Cincinnati milling machine, the blocks and keys being used to locate the work as in the preceding cases.

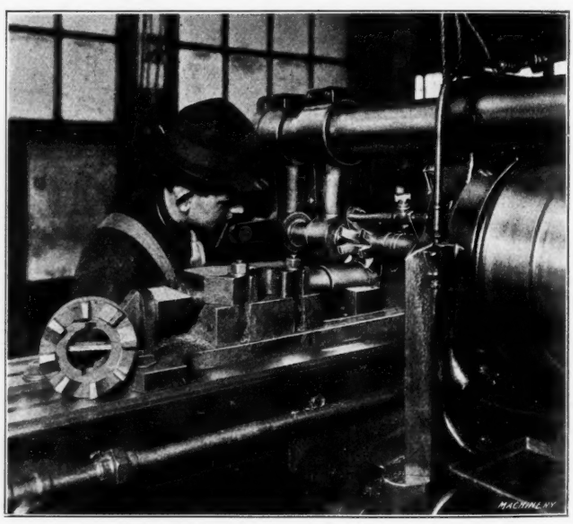


Fig. 13. Jig for Milling Feed Shafts for Coal Cutting Machines

A 9/16-inch cutter is now mounted on the arbor and with the blocks still in position under the keys, the slot is milled at the left-hand end of the shaft. The index plate *A* is now mounted at this end of the shaft. It will be seen that this plate has four slots milled in it, 90 degrees apart. These slots receive keys that are located against blocks in the same way as those at the center of the shaft are. The index plate is now adjusted so that the keys in the slots *C* and *E* rest properly on the jig blocks, and the plate and shaft are then secured in this position. The slot at the right-hand end of the shaft is then milled by means of the 5/8-inch cutter which has replaced the one used in the preceding operation. The shaft is then rotated 90 degrees, and located by means of the index plate and blocks. The keyway is then milled, which completes the machining operations.

# MANUFACTURE OF TUBING BY AUTOGENOUS WELDING*

By J. F. SPRINGER†

The trend of industrial processes, today, is in the direction of continuity. There is no doubt but that enormous losses are often entailed by the necessity of slowing down or stopping machinery for the disengagement of completed, and the attachment of new, work. If a process can be made continuous, a great advantage is gained, other things being equal. The rolling mill was an extraordinary advance over previous non-continuous methods, and to-day, in fact, an effort is being made to form short pieces, such as railway tie-plates, on the rolling mill. It is no wonder then that in consequence of the enormous demand for water, gas and steam piping, very determined efforts have been made to produce tubing by the process of rolling. The efforts have been successful, and steel tubing is now made in large quantities by this method. Strips of flat steel are rolled longitudinally between successive pairs of rolls until the edges meet or overlap. They are then butt- or lap-welded. This welding process, while more continuous, differs but little from that of the blacksmith.

In Germany, tubing is being made by the rolling of sheet metal and the subsequent welding with oxygen and acetylene, the process being continuous, and a special welding machine being used. Of course the welding machine can be used as an adjunct to any method of rolling, but in the particular case referred to, the rolling machine is of the type shown in Fig. 1. This machine receives the metal in long flat strips, which have either been specially rolled or cut to the required width. The first operation is accomplished by a pair of rolls which bend the longitudinal edges upward. These bent-up edges will ultimately form the "roof" of the tube. It is important that the degree of curvature of the bends shall be precisely that of the finished tube. Another pair of rolls just ahead receives the strip and bends it into a U-shaped form; the upper ends of the U-curve, however, are bent toward each other because of the side bends formed by the previous pair of rolls. Another pair of rolls is now employed to receive the U-shaped strip and cause it to approximate still more closely the tube-shape. Finally, another pair of rolls completes the bending to shape; a mandrel is employed with this pair. In case very elastic material is employed, it is advisable in the first pass to bend the axial portion so that when the tube is shaped it will point in toward the inside of the tube. In the last operation, this bend will be eliminated by the mandrel. The object is to obtain a joint with no tendency to open.

When a strip which has been cut from a sheet in the ordinary way is thus bent together, there will be a V-shaped groove along the joint. The reason for this is that the external circumference of an annular ring is longer than the internal one. The strip is of the same width on both sides, so that when one side is bent to form a complete inner circle, there is not enough material for the outer circle. The weld can still be made, but as machine welds use no additional metal, the section at the weld will be thinner than it ought to be. If the tubing is made of quite thin metal, no especial difficulty will arise from the formation of a groove; but when the wall is rather thick, strips which have been especially rolled to provide a greater width on one side than on the other should be used. When such a strip is bent to the final shape, we have a narrow V-shaped groove with ridges on each side. A narrow groove is advisable, because it admits the flame to the entire depth of the joint.

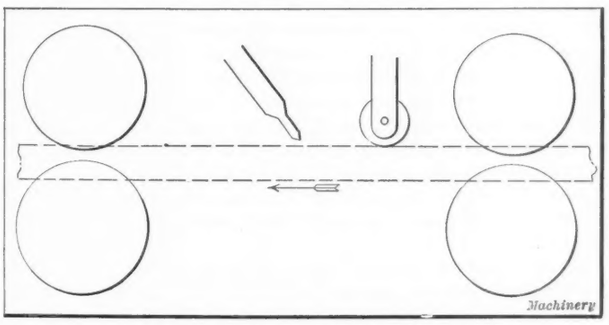



Fig. 3. Principle of Autogenous Tube Welding Machine

The welding machine is rather simple. Two pairs of compression rolls are placed a short distance apart, as indicated in the diagrammatical view, Fig. 3. These rolls carry the tube along, the one pair receiving it from the tube rolling mill. Between the two pairs of rolls a standard is placed to which is secured the device which holds the torch. This latter has its tip directed downward and toward the unwelded joint. The angle of inclination is about 45 degrees. The tubing, as it is fed along by the first pair of rolls, can scarcely be depended upon to keep its unwelded joint in a constantly uniform position. It is, however, necessary that the working flame of the torch and this joint shall be in an exact relation to each other. Therefore, a holder is provided which carries a roll or wheel having a thin edge or projection on its periphery. This edge enters into the groove at the joint and controls its position just before it reaches the torch. This machine is made of the duplex type, so that two welding operations may be handled at the same time; a torch and the necessary rolls are arranged on each side of the bed. Comparatively thin tubing, say 0.04 inch in thickness, can be welded at the rate of about 8 inches per second, or about 40 feet per minute. The rolling of the strips to the cylindrical form can be done at, perhaps, twenty times this rate.

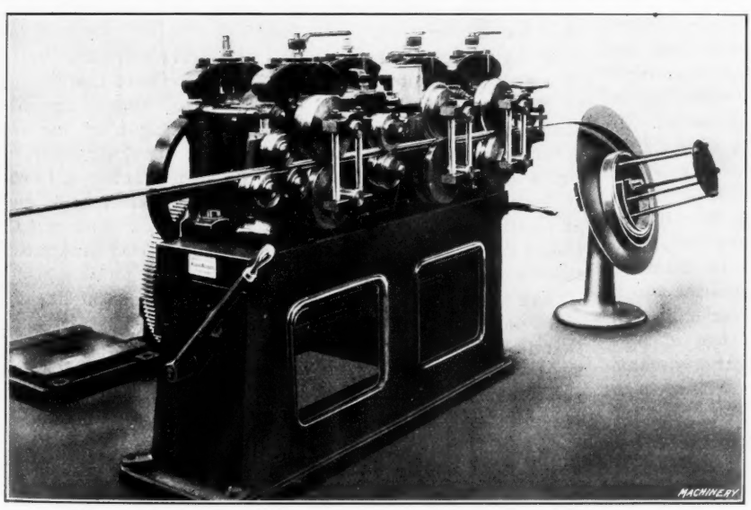



Fig. 1. Tube Rolling Machine built by August Schmitz, Dusseldorf, Germany

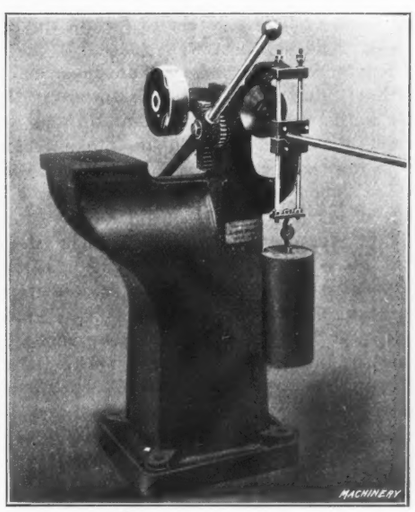



Fig. 2. Machine for Cutting-off the Welded Tubes

* The following articles on autogenous welding and kindred subjects have previously been published in MACHINERY: "The Oxy-acetylene Process and the Steel Car," May, 1911; "Goodyear Oxy-acetylene Equipment," December, 1910; "Dangerous Oxy-acetylene Apparatus," May, 1910; "Autogenous Welding as a Means of Repairing Cylinders," April, 1909. See also other articles referred to in the note accompanying the one last mentioned.

† Address: 608 W. 140th St., New York City.

It is frequently the custom in the bicycle industry to draw tubing to an oval or elliptical section. The most severe stresses to which such elliptical tubing is subjected would tend to injure the weld if the latter should be located at the end of either axis of the ellipse. It has been found advisable, therefore, to locate the seam to one side of the "sharp" end of the ellipse. A Swedish charcoal iron, containing very little carbon, is said to be most suitable for this class of work.

In the rolling of tubes of small diameter, it is permissible to roll in a longitudinal direction, but when we come to greater diameters, it becomes necessary, or at least advisable, to discard the continuous method and use rolls or other devices whose axes are parallel with that of the tube. Machines specially built for this service bend the sheets quickly to the required cylindrical form. Diameters of 3 to 10 inches are readily handled, the material having a thickness up to ¼ inch. The forming process requires from 7 to 12 minutes for each section of tubing, according to the length. The writer understands that machines for forming tubing of still larger diameters are built by the firm of August Schmitz, Düsseldorf, Germany, the maker of the machines illustrated in this article.

Large tubes are usually welded autogenously, by hand, but it is necessary that the operator shall not have to contend with any movements of the metal edges when the work is subject to the effects of the high temperature of the working flame, and a guide of some kind must, therefore, be employed. In dealing with the mechanical welding of rather heavy material, it becomes necessary to provide for something more than a mere relative movement in a straight line of work and torch. In one or more of the German machines there is a device which communicates a kind of circular motion to the welding torch and flame, in order to increase the heated area. Just why the same result could not be attained by the use of two torch tips side by side, is not very clear.

That large pipe made by the oxy-acetylene process is reliable is indicated by the following test: Two sections of such pipe, each about 39 feet long and 35 inches inside diameter had their flanges bolted together to form a single length of nearly 80 feet. The supports were placed at the ends so that the full length between them was unsupported. Then the double length of tubing was loaded with about thirty men, or, in other words, a load of more than two tons was supported. Of course this test does not take into account the question of the "water-tightness" of the weld. However, a test was carried out upon another piece of welded tubing—this time a bend—of about 2 feet inside diameter. The tube did not leak under a pressure of about 365 pounds per square inch. Another piece of tubing about 31 or 32 inches in diameter has been made by the welding process from material which was about 0.4 inch thick. A drainage system for a lock of the Kaiser-Wilhelm canal contains about 2000 feet of pipe welded by the autogenous process. One German firm is manufacturing hot water heaters by the same process. These heaters are made in lengths up to 9 feet, and diameters up to 39 inches.

* * *

## TO PREVENT DISCOLORATION OF CEILINGS OVER BELTS

In shops of the factory type having windows at the sides only, the difficulty of lighting in the center has been largely overcome in modern construction by using steel window sash and making the window openings upwards of eighty per cent of the wall space, and by painting the ceilings and pilasters a light tint. But it is one thing to paint ceilings a light tint and another to keep them from quickly becoming grimy. It is common experience that the ceiling areas immediately over belts quickly become discolored and in a short time black with dirt. The dust of the shop is heated and electrified in the vicinity of the belts, and being attracted by the ceiling clings to it. The trouble can be largely overcome, it is claimed, by stringing a parallel wire over the belt with short pointed wires attached and hanging down close to it. The wire must be grounded to act as an efficient conductor. The electrified particles of dust are atttracted to the wires and cling to them instead of to the ceiling. They can be cleaned off periodically with little labor and expense.

## HARD VS. SOFT CAST IRON FOR MACHINE TOOLS

By ROBERT GRIMSHAW*

In the August, 1911, number of MACHINERY, the opinions of a number of German machine builders, relating to the use of hard vs. soft cast-iron ways for machine tools, were recorded. In the following are given the opinions of a number of well-known English and French builders of machine tools and general machinery.

Bradbury & Co., Ltd., makers of sewing machines, cycles, and tools for electricians, Oldham, say that in their experience they have found a coarse-grained cast iron to wear best.

Joseph Evans & Sons, makers of pumps and pumping machinery, Wolverhampton, say: "We consider that the argument on the part of the American contingent of machine builders as to the lubricant being retained in soft iron, is entirely a matter of 'begging the question.' The chief complaint with regard to American machine tools is that the metal they are made of is so soft that it wears rapidly. Some few years ago we had occasion to buy a number of American machine tools. In these the cast iron was so soft that the slides and beds wore rapidly, and so soft and weak was the metal that failures of numerous parts took place. For instance, when the jaws were screwed up, they pulled bodily out of the face-plate of the chucks. Portions of the slides on the saddle, and other parts also broke off, and these things happened though we were working very much under the rated capacity of the lathes for the amount of cut and speed that was guaranteed (or, rather, set forth) as the capacity of the lathes and tools in the catalogues. Our opinion is, therefore, that the harder the slides and wearing surfaces are, the better they are."

R. & W. Hawthorn, Leslie & Co., Ltd., engineers and shipbuilders, Newcastle-on-Tyne, consider hard cast iron to be the best for the purpose. "Soft metal is more porous, and, in addition to retaining the oil, it retains grit and foreign matter, and these form a grinding medium which produces rapid wear on the surfaces."

Alfred Herbert, Ltd., machine tool makers, Coventry, write: "We may say emphatically that we believe hard cast iron to be the best for the slides of machine tools. One of the chief causes of wear of such slides is the grinding-in of fine dust between the sliding surfaces, which must obviously wear the slides more if soft than if hard. Our own practice is to cast all beds from a very hard metal; the metal must be as hard as possible, only it must not be too hard to machine. All the bodies and beds of our machines are cast in dried sand molds, thoroughly baked before pouring."

John Lang & Sons, lathe manufacturers and special machine-tool makers, Johnstone, near Glasgow, say: "We have found that it is better to make lathe beds and other parts which are to be used as guides for a saddle or slide, of hard metal, and with as little porosity as possible. We find this tends to durability and accuracy of guides for carriages of lathes and the like."

Société Anonyme des Anciens Etablissements Panhard & Levassor, Paris, writes: "We are of the opinion that it is best to employ a soft quality of iron, especially for slowly moving parts; further, if we consider the various machines in the shops, we find that those of soft iron have less tendency to bind through friction, which proves that lubrication is better assured."

Les Fils de A. Piat & Cie, operating foundries and machine-shops in Paris and Soissons, say: "Our decided opinion is that the rubbing parts of the carriages of machine tools should be made of the hardest material possible; the cast iron should be very dense and also very homogeneous. When in use, the rubbing parts then become glazed and polished and acquire an exceptional hardness; as a result, the wear is less than with soft iron; and even if the lubrication should become less than would be desirable, the resulting inconvenience is less, because the coefficient of friction is lower. From another point of view, the use of a hard cast iron permits more readily the redressing of the surfaces by scraping, and a greater degree of accuracy can be retained. Other things being equal,

* Address: Dresden—A 16, Gneisenaustr, 3, Germany.

and when the pressure per unit of surface is the only thing to be considered, hard iron surfaces can be less in area than soft ones, which diminishes the resistance due to adhesion and the power necessary to move the carriages."

A. Ransome & Co., Ltd., engineers and iron founders, Stanley Works, Newark-on-Trent, say: "Our experience is that cast slides of hard quality wear infinitely better and remain true longer than those made of soft cast iron. We note that some manufacturers hold a contrary view, maintaining that when the iron is porous the lubricant remains longer between the rubbing surfaces. The fact that slides are made of hard material should present no difficulty with the lubrication if the machines are properly constructed with this end in view. We have a large number of machine tools in use at our works here, manufactured by British, Continental and American firms. There is a marked difference in the quality of the cast iron used by different makers, but in every instance where the machines are made of soft material, the wear on the working parts is more rapid and the machines require more frequent adjustment. Our rule with the goods we manufacture ourselves is to invariably make the iron castings of a material which is sufficiently hard to wear well without being too hard to machine economically."

Scriven & Co., machine tool makers, say: "It seems to us that the best wearing surface is to be obtained by the use of a hard, tough iron. So far as concerns soft guides remaining true for a long period, due to their porosity helping the lubricant to remain longer between the rubbing surfaces, we think this advantage is more than counterbalanced by the fact that this same porosity will insure grit also being kept longer between the rubbing surfaces, and will rather cause excess of wear than otherwise."

The management of the Société des Etablissements Singrün, Golbey (Vosges), is of the opinion that "hard cast iron is preferable to soft. If the oil can lodge in the pores of the soft material, grains of dust and sand can lodge there equally well, and cannot be removed—hence, rapid wear. In this connection we have not only our experience with various machine tools, but also with the journals of turbines, which resist wear only when of hard cast iron; and the harder it is the longer they last."

John I. Thorncroft & Co., Ltd., Southampton, say: "In our opinion a hard bed is an advantage, and has a longer life than a soft."

H. W. Ward & Co., Ltd., Birmingham, say: "We do not think that there can be the slightest doubt but what hard cast iron is the most durable. We note the ingenious suggestion of the supporters of soft cast iron, to the effect that being porous, it will retain the lubricant longer; but it is obvious that if it is sufficiently porous to retain the lubricant the pores will also absorb fine grit, and so cut the slides. As a matter of fact we do not think that there is any real difference between the oil-retaining qualities of hard and soft cast iron; and if the surfaces are properly lubricated, the harder guides will certainly wear the longer."

Thomas Shanks & Co., Union Iron Works, Johnstone, near Glasgow, say: "We do not believe a coarse-grained iron holds the lubricant any better, so as to result in a better wearing surface remaining longer true."

Messrs. Willans & Robinson, Ltd., Victoria Works, Rugby, say: "In our opinion a hard, close-grained iron, with properly designed lubricating arrangements, is preferable."

H. Bollinckx, builder of Corliss engines, etc., Brussels, says: "In our opinion, soft cast iron is the better, for we notice that our Flather and Reed lathes wear less in the guides than lathes from other countries, and we note that these latter are of a harder cast iron."

Ludwig Loewe & Co., of Berlin, have published a pamphlet on foundry work in which they say that American cast iron has better resisting qualities, especially in bending; that is, it bends more without breaking.

The La Seyne department of the Société Anonyme des Forges et Chantiers de la Méditerranée, ship builders, etc., say that of all the machine tools in their shops, those of hard iron have generally given better results than those of soft iron. The latter wear much more rapidly, despite liberal lubrication.

Vickers Limited, Sheffield, writes: "We think it is generally admitted in engine and machine construction, that two metal pieces rubbing together should be dissimilar in character; and that the most expensive part to replace should be the hardest. For the same reason, in the best work, shafts are made of hard steel, and the bearings of relatively soft white metal."

The Bateman Machine Tool Co., Ltd., Balm Road, Hunslet, Leeds, say: "Our experience prompts us to say that hard guides and slides are superior to soft ones. The suggestion about soft guides retaining the lubricant does not appeal to us. It is the duty of the tool-builder to see that the lubrication is efficient, whether he employs hard materials or soft. It may be argued that soft slides are more easily corrected than hard ones; but on the other hand hard slides remain reliable for much longer periods. In the event of a machine being allowed to wear seriously out of truth, it will probably be easier to restore to accuracy soft materials than hard ones, but this is a remote contingency, and does not interest the better class of machine-tool users. We find there is a general feeling amongst users of machine tools in favor of fairly hard slides; and in fact, much of the decline in general favor of American tools is ascribed to the soft metal. Furthermore, soft slides on a table (planer or milling machine table) necessarily imply soft T slots and general weakness and yielding when clamping work."

* * *

## TESTING STEEL FOR GEARS

The requirements of the automobile makers in the gear line have caused many a sleepless night, and days of anxiety for those who have endeavored to make alloy-steel hardened and heat-treated gears to their satisfaction. A concern in the automobile zone of Michigan found, after one costly experience, that absolute knowledge of the chemical and physical characteristics of every bar of steel used in making gears was necessary. It has installed a chemical laboratory in which a sample from every bar is tested and a record made for future reference. That the practice pays is attested by the fact that the cost of the experience referred to would have paid the expenses of the laboratory and chemist for a year.

The company not only records the characteristics of all steel used in gears, but makes records of failures which occur in the shop or outside. The data thus being accumulated become of greater and greater value. The point to be fully understood and appreciated is that guesswork is reduced to a minimum by eliminating unknown factors. It is but another phase of what has come to be known as scientific management.

* * *

## REMOVING SEIZED SCREWS

When a screw "seizes" in a casting the mechanic generally twists it off, sets up an "old man" and ratchet drill, laboriously drills out the core of the screw, carefully chips out the shell with a hammer and cape chisel, and taps out the thread to a larger size. In the shop of the Cleveland Planer Co., Cleveland, Ohio, a different and far more effective method is employed. When a screw twists off a small hole is drilled with an electric breast drill into the casting at right angles, if possible, or to other angles so as to reach the cavity under the point of the screw. The hole is filled with kerosene, which is left for a few minutes to work its way into the screw threads. The chips and dust that have been collected by the tight screw are quickly loosened so that the screw can be easily backed out. On heavy erecting work the saving of time as compared by the common method is important. Mr. Dornbirer says: "It never fails."

* * *

Upon the recommendation of the Bureau of Standards of the U. S. government, a number of the principal wire manufacturers have agreed to designate in the future the "American Steel & Wire Co.'s gage," which is the same as the "Washburn and Moen gage," by the name "steel wire gage." In cases where it may be necessary to distinguish this gage from the British wire gage it may be designated as the "United States steel wire gage."

# THE FORMS OF LATHE BEDS—1

By JOSEPH G. HORNER*

## THE SECTIONS OF BEDS

All the early lathe beds were made of wood. Engravings showing some of these wooden beds may be seen in old works on turning. They are to be found now only in some of the lathes used by wood-turners, and in some pattern-shops, although in the latter case, lathes with iron beds are now almost exclusively used. Fig. 1 shows a wooden lathe bed or

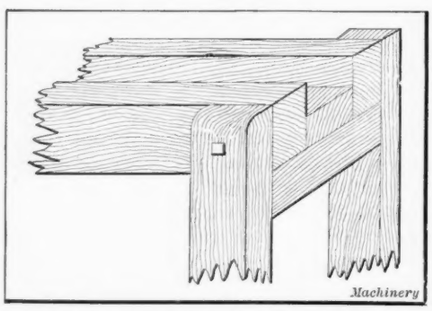



Fig. 1. A Common Type of Early Wooden Lathe Bed

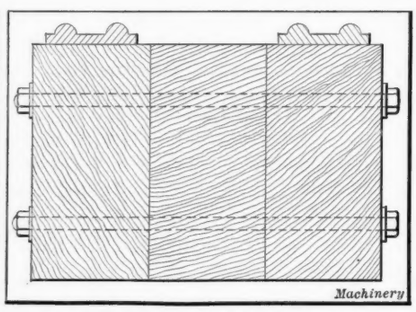



Fig. 2. Built-up Wooden Lathe Bed provided with Iron Ways

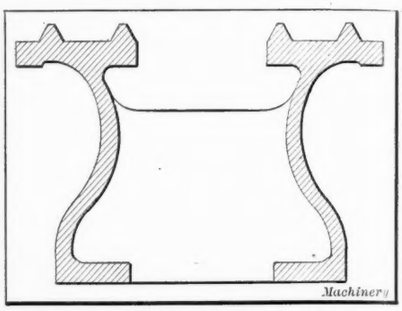



Fig. 3. Early Type of American Lathe Bed with Double Vee Guides

stand. Different methods were used for attaching the bearers or shears to the uprights. At a very early date the wear of the top surfaces of the wooden bearers was prevented by screwing thin flat iron plates onto them. Strips of wrought iron were also fitted, having curved edges chipped and filed to shape, as shown in Fig. 2. There was not a great deal of

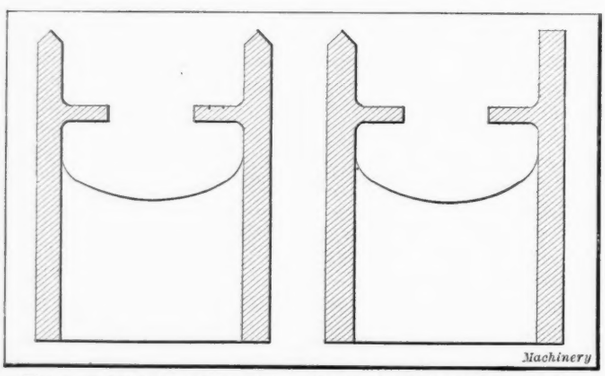



Fig. 4. Early Type of Lathe Bed with Double Vee

Fig. 5. An Early Lathe Bed with a Vee and a Flat Way

durability in these shears, but the chief objection to this construction was that when the timber warped, as it was bound to do in the course of time, it pulled the iron strips with it, and threw the headstock, tailstock, and rest out of alignment.

The first all-iron beds were of triangular section, the form probably originating with Henry Maudslay. A lathe designed

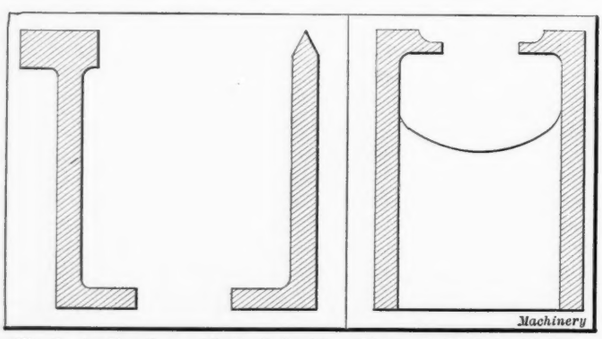



Fig. 6. Another Type of Lathe Bed with One Vee and One Broad Flat Shear

Fig. 7. Lathe Bed with Two Flat Ways

by him at a date previous to 1800, now in the South Kensington Museum, was illustrated in MACHINERY for September, 1909, in an article entitled: "Chapters in the Early History of Machine Tools." The bed was built of two bars of triangular section, secured in brackets bolted onto the legs. There was

* Address: 45 Sydney Buildings, Bath, England.

a very good reason for the adoption of this form of bed in preference to any other. There were no planing machines at that period—in the latter part of the eighteenth century—so that it was an important consideration to be able to reduce the chipping and filing to a minimum on a single bar. Besides, if the two upper faces were true, it made no difference whether the bottom one was true or not, because there was clearance between it and the tailstock and rest.

Lathe beds with a single shear of triangular section have often been built, although they are seldom seen now, except in the lathes used by watch- and clock-makers. These beds are sufficiently rigid for light duty, and chips do not lodge on them. The triangular-section lathe bed also possesses the virtue of insuring self-alignment of the tailstock and rest, which bear on the upper edges only. The essentials of the triangular bar section have been revived and perpetuated in the Pittler bed—referred to later—but in a modified and stronger, stiffer, and steadier form. The Pittler bed consists of a bar of trapezoidal section. The bar is hollow, and the lead-screw, passing through the hollow section, is thus protected. In some watchmakers' lathes, the essential features of the triangular bed are retained, but the lower side is of convex form. Some lathe beds are of cylindrical cross-section, either solid or hollow. All these types are simply variations of the single bar type, and are illustrated later in this article. Mention may also be made of square and rectangular beds,

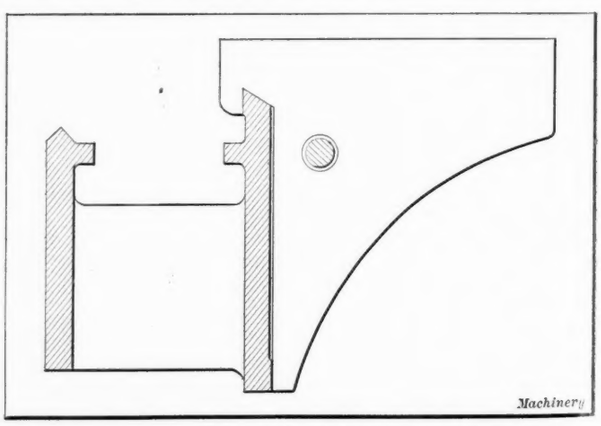



Fig. 8. Early Type of the Richard Roberts Lathe Bed with Front Slide

the latter being employed in a few of the peculiar French lathes used for screw making.

### Early Development of Lathe Beds

Since a single triangular bed was not stiff enough to resist the torsional stresses of heavy cuts, which produce vibration and cause the bed to spring, an early development was that of using two deep parallel bars or beam sections, cast separately and bolted together. In the next stage the two bars were cast in one piece with connecting ribs. It was still, however, necessary to reduce the labor of chipping and filing to the least amount consistent with the practical requirements of the time; hence the form shown in Fig. 4, in which the top vees of the triangular bars were still retained, represented standard practice, with or without the internal stiffening ribs which were cast to increase the rigidity in the lateral direction. Then modifications of the design in Fig. 4 were introduced

as shown in Fig. 5, where one vee is dispensed with, but the other retained for guidance. In Fig. 6, the width of the flat bearing surface is increased. This type of bed also made it easier than with two vees to fit the parts to a nicety. This construction is, for the same reason, employed instead of two vees in many lathes and grinding machines today. At last both bearing faces were made flat as shown in Fig. 7, and the longitudinal means for guidance offered by the vees

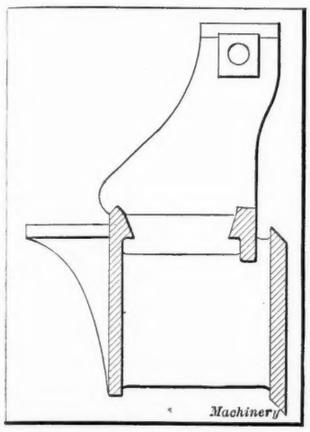



Fig. 9. Another Front Slide Lathe Bed

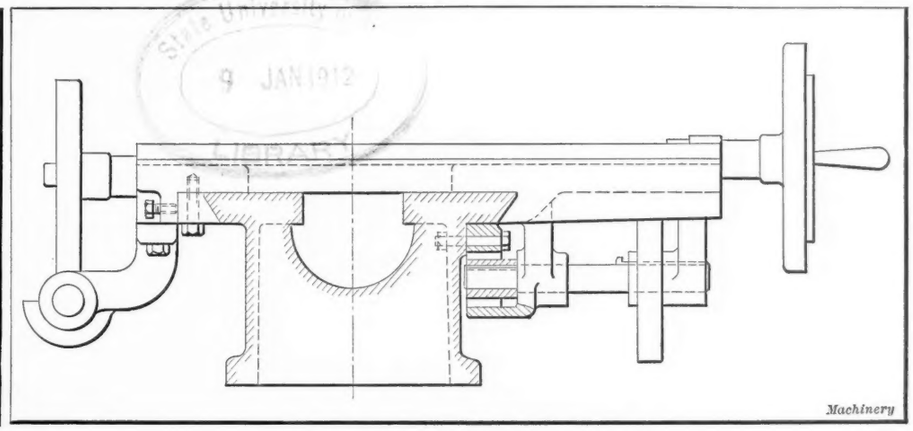



Fig. 10. An Ordinary English Type of Lathe Bed

was, therefore, abandoned. The lateral play was then prevented by making tenons on the heads fit between the edges of projecting internal ribs, as shown in Fig. 7. All finished surfaces were still kept narrow, however, until, after the invention of the planer, they developed into the present forms.

As the slide-rest developed, the battle of the vees and flats became intensified. The older upstanding vees are still retained—with modifications—as the only guiding elements in

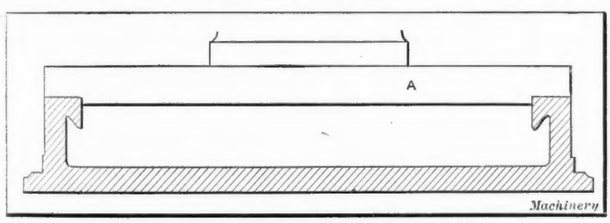



Fig. 11. Early Type of Bed for Heavy Lathes

standard American practice. At a comparatively recent date slight modifications have been made in some forms, in which a flat is combined with the vees; but the principal difference which exists even now is that of using either two or four distinct vee-ways. In the latter design, Fig. 3, the two inner vees guide the sliding tailstock, and the two outer ones, the carriage or saddle of the slide-rest. The inner vees are frequently sunk below the level of the outer ones to increase the

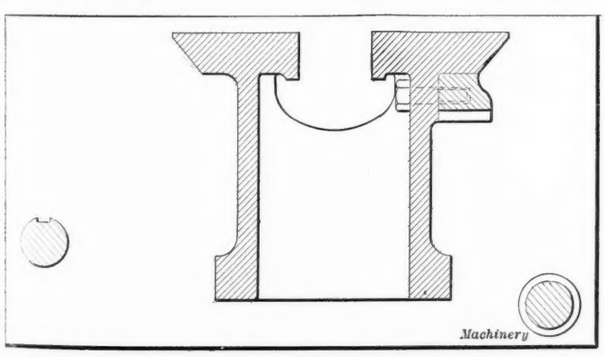



Fig. 12. Type of English Lathe Bed, Standard for a Long Period; Lead-screw and Feed-rod in Unsatisfactory Positions

swing of the lathe, and to enable a greater thickness of metal to be put into the carriage. Both vees are truncated or flattened more or less on the top. The type having two vees only, serving both for the carriage and the tailstock, is now chiefly used for the smaller classes of lathes.

In England, the vee-beds have been long since abandoned, except in a very few cases where an Anglo-American design is aimed at. The writer, however, remembers seeing some of the ancient lathes of that type, as shown in Fig. 4, and also in Figs. 5 and 6, still in use in the early years of his apprenticeship, and others which were at that time just being consigned to the scrap heap. The beds were extremely light in comparison with modern designs. The headstock pulleys were driven with ropes, not with belts. Both headstock and tailstock were very skeleton-like. The screw of the tailstock was not concealed in the barrel, but exposed. The largest of these lathes were, perhaps, of 24- or 28-inch swing, and the beds might have been twelve feet long.

Some of the early lathes with vees anticipated the modern forms of front-slide lathes. Figs. 8 and 9 illustrate beds of this type, as constructed by Richard Roberts, of Manchester, from about 1817 to 1820. They were probably the first of that type, and they do not differ essentially from modern lathes of a similar kind. In these illustrations two variations are shown. In one, dependence is placed on the guidance of one vee only, and the lower edge of the front slide bears against a plain face. In the other, a bottom vee is included, with a setting-up strip. Note in Fig. 9 that the centers of the heads

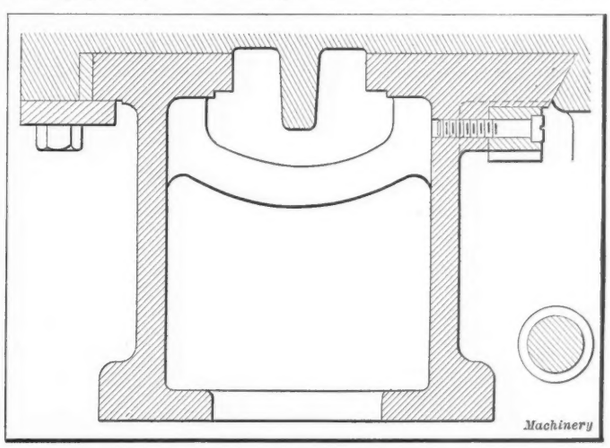



Fig. 13. Another English Lathe Bed of Standard Design

are brought forward in front of the bed center. The remainder of the design is in harmony with the practice of that period.

Fig. 11 illustrates the section of the bed of a large lathe which also was designed to perform the function of a boring mill; it was built by a Dundee firm before 1847. In this case the bed is very shallow, and its ways flat, with internal inverted vees. The plate *A* represents both the base of the tailstock and the carriage of the slide-rest. Hook-bolts embracing the vees and passing up through the plate, were used for clamping. In this machine, as in some others of that period, no power feed was available to the carriage, but only a hand traverse of the tool-holder. The carriage was adjusted by hand through a pinion and rack. In this lathe, the movements of the carriages of fifty years earlier were thus retained.

In the usual type of English lathe bed, Fig. 12, the vees are abandoned for ways having broader surfaces, and their place

as guides is taken by the edges of the ways. The inner edges take care of the alignment of the headstock and tailstock, and the outer ones take care of the slide-rest or carriage. The outer guides may either both be in the form of vees, as in Figs. 10 and 12, or one may be square and one vee-shaped, as in Fig. 13. In some cases both edges may be square. These types have long been standardized, but there are many variations. It is from this starting point that we propose to consider the forms of lathe beds as they are designed today.

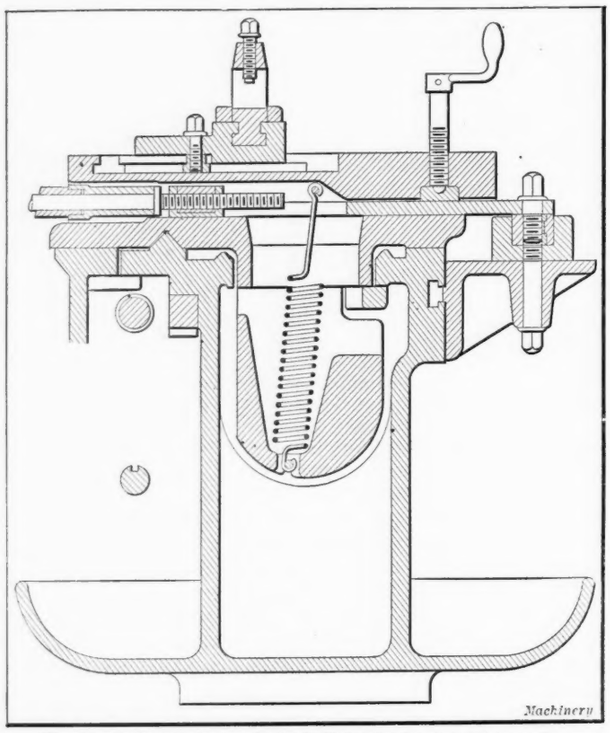



Fig. 14. Bed of Tool-room Lathe built by the Pratt & Whitney Co., Hartford, Conn.

### Flat vs. V-shaped Lathe Shears

The transition from the upstanding vees to the flat ways has been a gradual one. The adoption of one flat with one vee, which dates a century back, has gone through various phases of development, besides those shown in previous illustrations. In America, an old type of bed by the Brown & Sharpe Mfg. Co. (who do not now make ordinary turning or "engine" lathes) was substituted for the beds with four vees. In this case the vee was employed for guidance, in conjunction with a suspended weight. The carriage was also gibbed on the square edge, which was situated at the back of the lathe. The Pratt & Whitney Co.'s tool-room lathe has a bed of the vee and flat type, as shown in Fig. 14. This design is also interesting because of the use made of a coiled spring in place of the suspended weight, which, through its inertia, is liable to cause vibration.

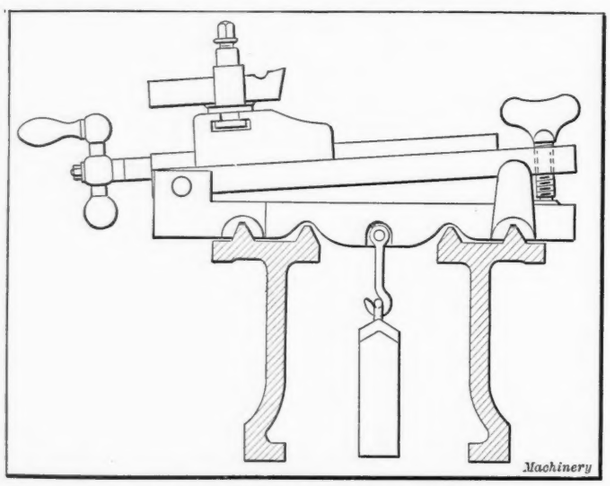



Fig. 15. Lathe Bed with Weighted Carriage

The battle between the vees and flats has given occasion to much fruitless controversy, since both types are retained tenaciously. There is much to be said in favor of the guiding qualities of an upstanding vee, and much also for the greater durability of a broad flat surface, and of the solidity of the carriage employed in conjunction with the latter. That these differences were recognized at an early period is evidenced by the frequent combination of a vee with a flat, and also by the use of two sets of vees, the outer set being reserved for the slide-rest or carriage. This not only divides the wear due to the movements of the tailstock and the carriage between two sets of vees, but also affords a broader base for the carriage, with corresponding gain in its stability. The self-aligning property of the vees is too obvious to require demonstration. In the flat beds self-alignment is absent. If the tenons of the tailstock wear, a loose fit results. In many lathes, however, provision is incorporated for clamping the tongue of the tailstock against the edge of one way only, thus not attempting to make a fit against the other. As a rule, the headstocks are then not fitted at all, but are adjusted by means of screws passing through the tenons.

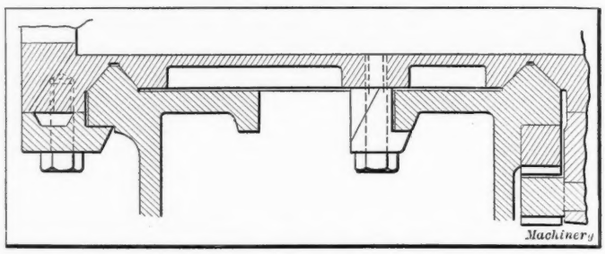



Fig. 16. Example of Gibbed Vee Bed

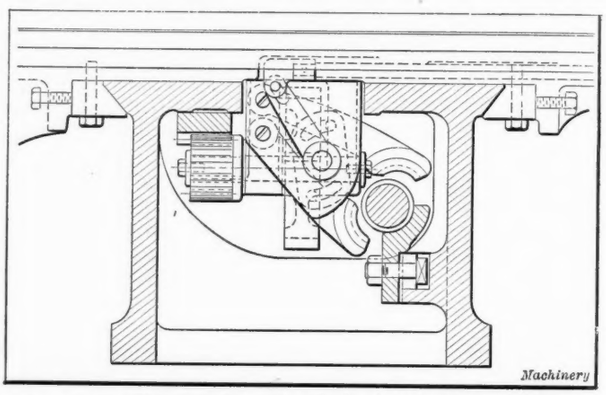



Fig. 17. The Whitworth Bed used in Lathes built by W. G. Armstrong, Whitworth & Co., Manchester, England

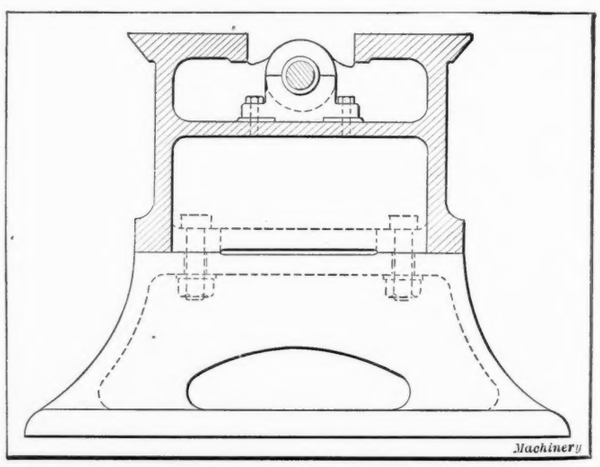



Fig. 18. A Whitworth Lathe Bed with a Central Lead-screw and Web

Though the wear on the vee-ways is uniform, they lack the advantage which the flat ways with vee-edges possess, namely, that of preventing the saddle of the slide-rest from being lifted

during cutting. Hence all the early beds were commonly united only at the ends, leaving the entire length clear for a holding-down device. This frequently consisted of a center-weight suspended from the carriage, and traveling with it, as shown in Fig. 15. When increased duty was demanded, and the beds were tied together with cross-ribs, the suspended weight could not be used. Then clamping or gib-plates were introduced underneath the edges of the bed, as in those Eng-

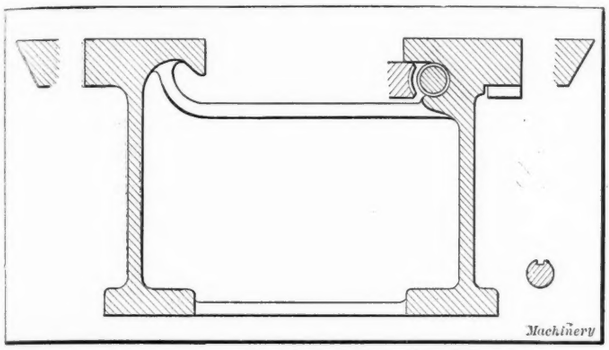



Fig. 19. A Type of Bed used in a Lathe built by Wm. Sellers & Co., Inc. Philadelphia, Pa.

lish designs which have square edges. Sometimes the gib or gibs are fitted underneath the internal edges. An example of this, taken from an Italian lathe, is shown in Fig. 16, where one gib strip is located on the under lip of the back shear, and another on the inner lip of the front shear, this arrangement being adopted because the construction of the carriage does not provide room for a strip at the front edge. Gibs bearing against both the inner and outer lips are also employed.

The points in favor of vee-shears may be summarized as follows: The wear is uniform, and loose fits cannot develop

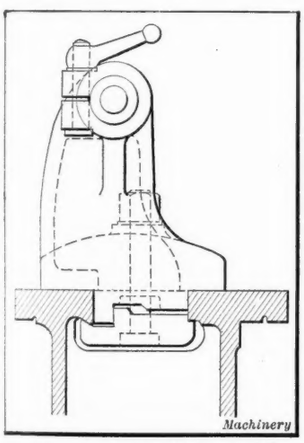



Fig. 20. Lathe with Inverted Vee for Clamping, built by G. Birch & Co., Manchester, England

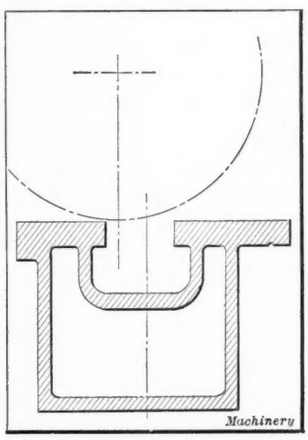



Fig. 21. Closed Box Lathe Bed of a Type Manufactured by Thomas Ryder & Son, Bolton, England

as in flat ways with square edges; the chips fall off freely; the rapidity of the wear can be largely minimized by increasing the length of the carriage; and the clamping of the heads on the vees helps to tie the sides of the bed together and stiffen them. The risk of damage to the edges of the vees, which might be mentioned as an objection to vee-shears, can be lessened by rounding them. The arguments in favor of flat ways and against vees are briefly: Wear is so long delayed that little account need be taken of it; its effects can be counteracted by fitting the tenons of the tailstock to the edge of one shear, and as regards the saddle by the setting-up of the gibs; the elevation of the vees permits of less swing than do the flat ways.

### Location of Lead-screw and Feed-rod

Inseparable from the design of the bed sections are the problems of the location of the lead-screw and feed-rod. It is an interesting fact that the old eighteenth-century lathe of Maudslay's has the lead-screw enclosed within the shears of the bed, thus anticipating the Whitworth design of nearly half a century later. The Whitworth bed, with the location of the lead-screw, is shown in Fig. 17. In this the divided clasp-nut is retained, operated by cam plate and levers through pulling or pushing a rod which passes to the front of the saddle. The supporting bearings for part of the circumference of the lead-screw should be noted. The position of the rack is not always as shown; frequently it is placed at the front of the bed. Fig. 18 shows a special Whitworth bed having the lead-screw placed exactly in the center, supported around nearly half its circumference by bearings located at intervals.

Several firms manufacture lathes with lead-screws protected in various ways. In standard English practice the lead-screw has long been placed outside at the front, and the feed-rod or "back-shaft" outside at the back. (See Fig. 12.) As a result of the influence of American practice many lathes are now built with lead-screw and feed-rod both in front and close together, and both with the rack traverse operated by gears enclosed in an apron. This is in harmony with the idea of

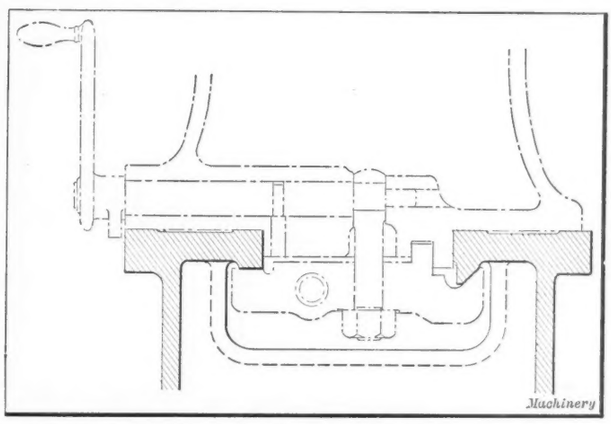



Fig. 22. Inverted Vee Lathe Bed for Clamping Turret Base, made by De Fries & Co., Dusseldorf, Germany

obtaining the motion required for screw cutting and feed from a gear box on the bed in front of the headstock; it also permits a more compact arrangement of the carriage. It may be stated as a general rule that the best English makers now place the feed-rod in front in preference to placing it at the back, and there seems to be no doubt but that in a short time the old "back-shaft" will disappear.

### Development of the Sellers Lathe Bed

The section of a bed used in lathes built by Messrs. William Sellers & Co., Inc., as shown in Fig. 19, illustrates the transitional form which under different modifications appears in many lathe beds of the present day. The vee-sections at the

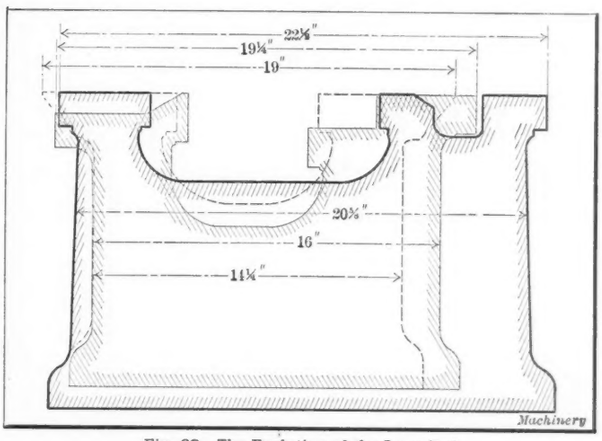



Fig. 23. The Evolution of the Lang Bed

sides in the illustration represent the earlier, and the central portion, the later type. The earlier design is similar to the standard English bed, in so far as the fitting of the sliding parts to flat ways and vee-edges at front and back is concerned; but the lead-screw is protected under the front shear in a recess provided specially for it. An inverted vee underneath the back shear is used to clamp the tenon of the tailstock against the vertical edge of the back shear, instead

of trying to make its tenon fit between both shears permanently, which is not practicable. Messrs. Sellers & Co. adopted this method in order to retain the same advantage of alignment (notwithstanding wear of the tenon or tongue of the tailstock) as is secured by the use of vee-ways, thereby taking advantage of the durability of the flat ways without suffering from the disadvantage due to the wear of the tenons.

The experience with the beds having vee-edges at front and back, as shown at the sides in Fig. 19 demonstrated that almost the only wear which occurred took place on the top faces, and not on the beveled edges; hence the abandonment of the vees in favor of square edges which maintain the traverse of the carriage parallel with the axis of the live

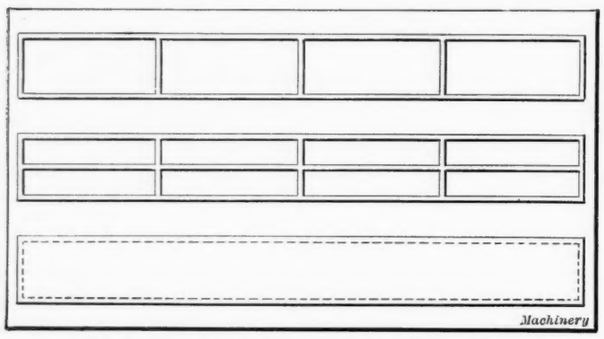



Fig. 24. Experimental Beds investigated by Prof. Sweet

and tailstock spindles, while the inverted vee maintains the tailstock spindle in alignment with the live spindle. The later type, therefore, provides for the permanent retention of the accuracy imparted to the lathe when new, and also provides for the protection of the lead-screw. The advantages of this design have been recognized, and it has been imitated in numerous later lathes.

The protection afforded to the lead-screw is so important a matter that many devices for this purpose have been adopted since the time when Whitworth placed it within, instead of outside, the shears. The Sellers' design embodies a decided improvement, for in it the lead-screw is supported along its entire length by the recess which is provided for it, and, therefore, it cannot be deflected. But the half-nut is single, and only extends around a rather small arc of the circle. These Sellers' beds also were among the first American make which embodied the use of cross-ribs.

Two examples of the employment of the inverted vee are seen in Figs. 20 and 22, the first showing the arrangement of the clamping plate in relation to the tailstock tongue, and the second a somewhat similar construction on a German chucking lathe. The base of the turret in this latter case is always pulled over toward the inner edge by the action of the clamping plate, which is pulled upwards by means of an eccentric bolt and lever.

### Strength of Lathe Beds

Another development is that of the stiffening and strengthening of lathe beds. All the old types were mere skeletons, although some of them were stiffened laterally as shown, with ribs placed internally or externally. Gradually, the thickness of the metal was increased, and the ways widened; fillets were cast along the bottom edges in addition to the cross-ribs. Many of the American beds were of a highly molded section, as shown in Fig. 3, with the object of imparting stiffness chiefly in the lateral direction, and so help to compensate for the absence of cross-ribs.

Lathe beds must always be made much stronger than they would have to be in order to merely prevent fracture. The stresses to be resisted are in the first place flexure; but it is fully as important that the design be stiff enough and heavy enough to resist the tendency to torsion and to vibration—to chattering. The massing of the metal may solve the problem, but it must be done judiciously. Flexure may be met by increasing the depth, because the strength increases as the square of the depth. Torsion is more difficult to prevent, while resistance to vibration demands a mass of metal obtained only by considerably increasing the dimensions which are required to prevent flexure and torsion. Experiments have been undertaken at various times from which certain broad deductions have been made; but lathe beds are, notwithstanding, mainly evolved from previous practical experience. Although the general movement has been going on for a century, this evolution has been especially noteworthy since the advent of high-speed steel.

The flexure of a lathe bed is more than allowed for by the proportions given to it for general strength. A very light bed might possibly be bent by the placing of a very heavy piece of work between the centers, or by the stress of heavy cutting near the center of the bed. In some American beds the standards or legs have been set a certain distance inwards from the ends in order to shorten the length of the unsupported portion. Sometimes the beds are cambered or fish-bellied; long beds have legs in addition to those at the ends; or in heavy lathes, the bed is continuous and rests on foundations located at intervals. An unsupported length which will not bend, provided the bed is of a box section, is given by Mr. Richards as one which is not more than twelve times its depth.

An interesting example of the gradual increase in bed dimensions for one size of lathe is shown in Fig. 23. This engraving illustrates the evolution of the lathe bed of Messrs. John Lang & Sons, of Johnstone, Scotland. The ordinary English type is seen in dotted outline; this type was employed by the firm previous to 1900. The thin full lines show the first narrow guide type of bed of 1900, and the thick full lines the present type.

### Lathe Beds of Box Section

Torsion can be best avoided, as far as the shape of the bed is concerned, by making it of a box section. Comparatively few lathe beds are, however, constructed in that manner, the general design being that of two shears connected by cross-bars or ribs, thus leaving the top and bottom edges unconnected. That this is a poor design is admitted, but it is one which is more easily molded than a box shape. Long ago Prof. Sweet had some castings made for a test,

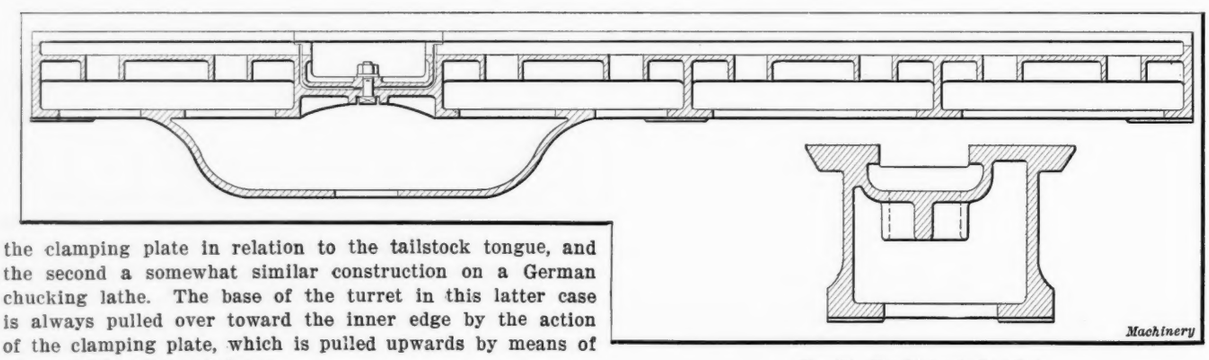



Fig. 25. The Richards Box Bed

as indicated in Fig. 24. These castings represent, respectively, the open-frame and the box type of beds, with the same amount of metal in each. The box casting proved much stiffer laterally, and thirteen times more rigid against torsion.

Several firms now construct beds which are wholly or partially boxed. It is, of course, necessary to leave some provision in the form of openings for the escape of chips and oil. Messrs. George Richards & Co., Ltd., of Manchester, England, though they have now given up the manufacture of ordinary lathes, were in the field when this departure was made. Their first lathe beds were made as shown in Fig. 25. The beds were practically encased along the top,

and well tied to the cross-ribs along the bottom with broad flanges. Holes cast in the top casing permitted the chips to fall through. The holes were surrounded by a rib to prevent loss of strength due to the cutting of the holes. Otherwise, in its general design, the bed is of ordinary English type, with flat ways, vee-edges, and a gap.

In Fig. 21 is shown a section of the beds of the lathes manufactured by Messrs. Thos. Ryder & Son, of Bolton, England. These beds are of solid box section. In this design the practice of bringing the lathe centers considerably behind the center of the bed is adopted, in order to afford additional support to the cutting tool when turning large diameters. The depth of the rear guide strip of the bed is also deepened to increase its durability.

Dr. Nicolson has stated that if the same amount of metal put into the ordinary beds were put into the box-shaped or the circular form, these types would be from six to ten times as strong to resist twisting. This is not so high an estimate as that given many years ago by Prof. Sweet, but it is amply high enough to justify that departure from the old practice which several lathe makers now have adopted. The solid box form is practicable, and easily manufactured; but the circular form is not, except in light lathes, such as those used by watch- and clock-makers, amateurs, and scientific workers. For such purposes, several examples of this type are built. The circular bed must have a longitudinal guide or guides for the headstock and slide-rest or carriage, and it is here that the difficulty arises in massive designs. In fact, for heavy designs, the circular bed may be dismissed as nearly impracticable, or at least undesirable, in face of the fact that boxed beds of rectangular section can be and are constructed better and more cheaply, and of equal strength.

* * *

## TWO-STAGE AIR CYLINDERS*†

### PRESSURES AT WHICH WORK IS EQUAL IN EACH CYLINDER

By J. WILLIAM JONES‡

Until about ten years ago the average terminal gage air pressure required of an air compressor did not exceed seventy or eighty pounds per square inch; consequently single-stage compression was almost universally employed. The use of higher pressures in compressed air service brought about the employment of stage compression which has proved to be more economical and practical for all pressures exceeding seventy pounds per square inch. It is safe to state that about eighty to ninety per cent of all the compressors sold in this country during the past five years have what is called compound or two-stage air cylinders. The majority of these were probably built for discharge pressures of about one hundred pounds per square inch, but there seems to be no uniformity among the users of compressed air as to what constitutes a standard pressure for a certain line of work.

The different purposes for which compressed air is utilized, naturally demand various discharge pressures. The constantly increasing application of compressed air to the numerous purposes for which it is adapted at the present day requires air pressures in two-stage machines varying all the way from seventy to five hundred pounds per square inch. Where one shop uses eighty pounds pressure per square inch for the operation of pneumatic tools it will be found that another uses ninety pounds, and still another one hundred pounds; one contractor will want to carry a line pressure of one hundred pounds for operating his rock drills and another will insist that he must carry one hundred and ten pounds. In the oil fields, for pumping oil, pressures ranging all the way from one hundred and fifty pounds up to five hundred pounds are required. New fields requiring higher pressures than those used heretofore for the ordinary lines of work for which compressed air has been the chief motive power are constantly presenting themselves.

In perusing the catalogues of the larger builders of compressed air machinery, it will be noted that they are now listing medium duty and high duty compressor sizes, the former having the cylinders proportioned correctly for pressures ranging from eighty to one hundred pounds and the latter for pressures ranging from one hundred to one hundred and twenty-five pounds. In addition to the above they carry a line of cylinder sizes which can be readily applied to the various compressor types for pressures ranging all the way from one hundred and fifty to five hundred pounds per square inch.

To know just what compound cylinder combination should be used for a specified terminal gage air pressure, requires some knowledge of the theory of air compression as well as a somewhat complicated arithmetical computation. The theory is not always easily remembered and errors are liable to occur in making lengthy computations. The accompanying Data Sheet Supplement solves the problems at a glance, requiring no knowledge of the theory of compression and no computations whatever.

Referring to Sheet I, the curves of which have been plotted for sea level conditions, let it be assumed that it is desired to know at what terminal gage air pressure the total work will be equally divided between two compound air cylinders of certain dimensions. Assuming that the compressor has a low pressure air cylinder twenty inches diameter and a high pressure cylinder ten inches diameter, the stroke being common to both cylinders, the low pressure cylinder diameter, twenty inches, will be found along the left-hand margin. Now projecting this point along the horizontal line in the direction shown by the arrow until the dotted line intersects with the curved line marked ten inches, and thence in a vertical direction until the upper margin is reached, the answer is found which in this case is two hundred twenty pounds per square inch; that is, an air compressor having a low pressure cylinder twenty inches diameter and a high pressure ten inches diameter with the stroke the same in both cylinders will have the total horsepower equally divided between the two cylinders when compressing to a final gage discharge pressure of two hundred twenty pounds per square inch, assuming the initial temperature to be the same in each cylinder which is equal to perfect intercooling between the two stages.

On the other hand, if it is desired to know what cylinder combination should be used for a specified terminal pressure, it is only necessary to first compute the diameter and stroke of the low pressure cylinder in relation to the desired piston displacement and then, starting at the upper border line at the required discharge pressure and at the left-hand border line at the correct low pressure cylinder diameter, note near what high pressure cylinder curve these two points cross when projected towards the curves. The above rules apply for any cylinder combination which the charts show and on any one of the three charts which have the curves plotted for sea level, five thousand and ten thousand feet altitude, respectively.

The formula for determining the final gage air pressure per square inch of any two-stage compressor in order to have the total horsepower required divided equally in each cylinder, is as follows:

$$P_3 = \left[\left(\frac{D^2}{d^2}\right)^2 \times P\right] - P$$

in which

$P$ = atmospheric pressure in pounds per square inch.
$P_3$ = terminal gage air pressure in pounds per square inch.
$D$ = diameter of low pressure air cylinder in inches.
$d$ = diameter of high pressure air cylinder in inches.

*Example:* Having a low pressure cylinder 20 inches diameter and a high pressure cylinder 10 inches diameter, it is required to find the terminal gage air pressure per square inch ($P_3$) at which the work is equal in each cylinder at sea level; the atmospheric pressure being 14.7 pounds per square inch.

$$P_3 = \left[\left(\frac{20^2}{10^2}\right)^2 \times 14.7\right] - 14.7 = 220.5 \text{ pounds.}$$

In the accompanying table are given the values of $\frac{D^2}{d^2}$ for vari-

* With Data Sheet Supplement.

† The following articles on this and kindred subjects have previously been published in MACHINERY: June, 1911, engineering edition, "Air Compressor Design"; December, 1910, engineering edition, "Horsepower required to Compress Air"; August, 1910, engineering edition, "High-pressure Cylinder Diameters for Air Compressors"; March, 1910, engineering edition, "Air Compressor Testing"; November, 1909, engineering edition, "Compressor Designing—The Distribution of the Load." See also MACHINERY'S Data Sheets No. 133, "High-pressure Cylinder Diameters for Air Compressors"; and No. 137, "Horsepower required to Compress Air."

‡ Address: 70 E. Second St., Corning, N. Y.

ous gage pressures from 75 to 500 pounds inclusive. This information is of value in computing cylinder sizes when the terminal gage air pressure is a settled fact. The diameter and stroke of the low pressure cylinder having been first determined relative to the required piston displacement, the diameter of the high pressure piston required to divide the load equally between the two cylinders is found by dividing the factor opposite the known gage discharge pressure into the area of the low pressure piston, to obtain the area of the high pressure. For 200 pounds final discharge pressure at 5000 feet altitude, the factor in the table is found to be 4.17. Assuming that a 25-inch diameter low pressure cylinder is required to give the necessary piston displacement, the area of the high pressure cylinder would be equal to the area of the low pressure, or 490.87 square inches, divided by 4.17 which gives a high pressure cylinder having an area of 117.6 square inches. This area is equal to a diameter of approximately 12¼ inches.

In theory the cylinders should be proportioned exactly in accordance with the above, all of which is based on the assumption that the intercooler reduces the temperature of the air to the original between the two stages. The intercoolers of the present day, however, can not be relied upon to do this, which means that, with the cylinders proportioned as above stated, the low pressure or intake cylinder would be required to do more than its share of the work due to the higher mean pressure in the cooler, on account of the thermal conditions not being perfect. It is, therefore, good practice to make the high pressure cylinder diameter a little in excess of the actual figures which the theoretical conditions show; that is, if the computation for the high pressure cylinder should result in a diameter of 9½ inches it would be good practice to call this diameter 10 inches.

Although the rules already mentioned are theoretically correct, it is possible to vary the proportions of the cylinders

VALUES OF $\frac{D^2}{d^2}$ (CYLINDER RATIOS) COMPOUND AIR CYLINDERS

Initial Temperature in Both Cylinders 60° F.

| Gage Pressure, Pounds | Sea Level | 5000 Feet | 10,000 Feet | Gage Pressure, Pounds | Sea Level | 5000 Feet | 10,000 Feet |
|---|---|---|---|---|---|---|---|
| 75 | 2.47 | 2.67 | 2.91 | 185 | 3.69 | 4.01 | 4.41 |
| 80 | 2.54 | 2.74 | 2.99 | 190 | 3.73 | 4.06 | 4.46 |
| 85 | 2.60 | 2.82 | 3.08 | 195 | 3.77 | 4.11 | 4.52 |
| 90 | 2.67 | 2.89 | 3.16 | 200 | 3.82 | 4.17 | 4.57 |
| 95 | 2.73 | 2.96 | 3.24 | 210 | 3.91 | 4.26 | 4.68 |
| 100 | 2.79 | 3.03 | 3.31 | 220 | 3.99 | 4.36 | 4.78 |
| 105 | 2.85 | 3.09 | 3.39 | 230 | 4.07 | 4.45 | 4.89 |
| 110 | 2.91 | 3.16 | 3.46 | 240 | 4.15 | 4.54 | 4.99 |
| 115 | 2.97 | 3.22 | 3.53 | 250 | 4.23 | 4.63 | 5.08 |
| 120 | 3.02 | 3.29 | 3.60 | 260 | 4.32 | 4.72 | 5.18 |
| 125 | 3.08 | 3.35 | 3.66 | 270 | 4.39 | 4.81 | 5.28 |
| 130 | 3.14 | 3.41 | 3.74 | 280 | 4.47 | 4.89 | 5.37 |
| 135 | 3.19 | 3.47 | 3.81 | 290 | 4.54 | 4.97 | 5.46 |
| 140 | 3.24 | 3.52 | 3.87 | 300 | 4.62 | 5.06 | 5.56 |
| 145 | 3.29 | 3.58 | 3.93 | 325 | 4.80 | 5.25 | 5.77 |
| 150 | 3.35 | 3.65 | 3.99 | 350 | 4.98 | 5.44 | 5.98 |
| 155 | 3.40 | 3.70 | 4.06 | 375 | 5.14 | 5.62 | 6.18 |
| 160 | 3.45 | 3.75 | 4.12 | 400 | 5.30 | 5.80 | 6.38 |
| 165 | 3.50 | 3.80 | 4.18 | 425 | 5.46 | 5.98 | 6.57 |
| 170 | 3.55 | 3.86 | 4.24 | 450 | 5.62 | 6.15 | 6.75 |
| 175 | 3.59 | 3.92 | 4.30 | 475 | 5.77 | 6.31 | 6.94 |
| 180 | 3.64 | 3.97 | 4.36 | 500 | 5.92 | 6.48 | 7.12 |

$D$ = diameter low pressure air cylinder.
$d$ = diameter high pressure air cylinder.
Atmospheric pressure at sea level = 14.7 pounds per square inch.
Atmospheric pressure at 5000 feet = 12.2 pounds per square inch.
Atmospheric pressure at 10,000 feet = 10.07 pounds per square inch.

to some extent for any specified pressure without unbalancing the work to any appreciable amount. To show the actual relations between the horsepower, etc., in the two cylinders, the curves in the accompanying chart have been plotted. These curves show the theoretical horsepower required in either the high or low pressure cylinder when compressing to 100 pounds terminal gage pressure with different cylinder ratios. Also a curve for this pressure has been plotted showing the combined horsepower of the two cylinders with these different cylinder ratios. It will be noticed that the minimum horsepower is required when the ratio of compression is the same in both high and low pressure cylinders. In this case the ratio of compression should be 2.79, which requires 7.72 horsepower in each cylinder when compressing 100 cubic feet of free air per minute to 100 pounds gage pressure, or the minimum total of 15.44 horsepower in the two cylinders. This ratio of compression when the same in both cylinders, is also the theoretical ratio of cylinder volumes. The values $\frac{D^2}{d^2}$ already referred to in the accompanying table, are nothing more nor less than the correct

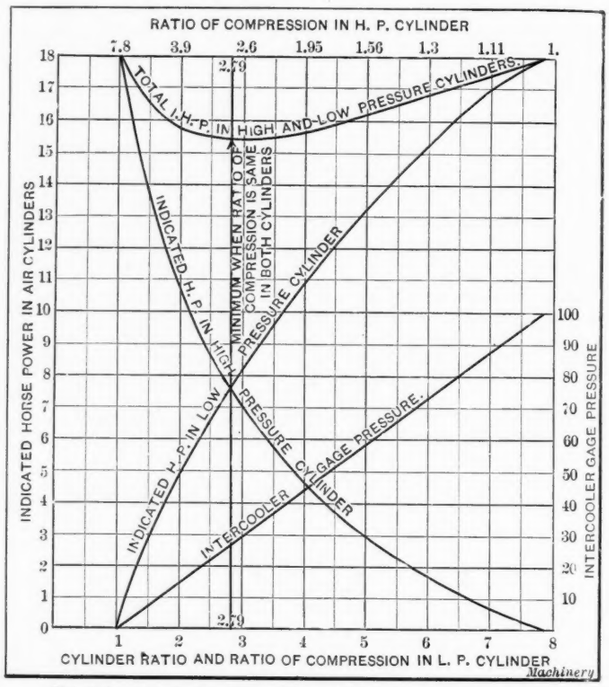



Chart showing the Horsepower required in Two-stage Air Cylinders with Different Cylinder Ratios when Compressing 100 Cubic Feet Free Air per Minute to 100 Pounds Gage Pressure at Sea Level

cylinder ratios for the pressures listed and at the different altitudes specified in this table.

In observing the curve showing the total horsepower in the chart it will be noted that it is very flat at the point of minimum horsepower. This means that it is possible to vary the cylinder ratio to a greater or less degree than the theoretical conditions shown without affecting the total horsepower to any great degree. A safe figure would be about ten per cent above or below the theoretical, preferably below for the reasons already assigned to imperfect intercooling. A good rule for compressors delivering air at 100 pounds gage pressure is to make the area of the low pressure piston two and one-half times the area of the high pressure.

The intercooler pressure naturally varies according to the cylinder ratio; to show these pressures, a curve for the different cylinder ratios has been included.

* * *

## WHEELBARROW AND TRUCK SPRINGS

The idea of fitting springs to a wheelbarrow may seem novel and ridiculous, but it is neither new nor unsound. A springless vehicle draws or pushes harder than if provided with springs, the reason being that the load must be lifted instantly whenever the wheels roll over obstructions. If the load is spring-supported the wheels roll over obstructions and transmit the impulse through the springs to the load, but not instantly. The time element reduces the peak of the traction load which is important in its influence on the endurance of the muscular system of men or horses. Wheelbarrows with springs were made by local wheelwrights years ago, but the modern contractor prefers to buy a cheap wooden affair costing a dollar-and-a-quarter to paying fifty cents more and getting a barrow that might increase the efficiency of his labor ten per cent. The increase of efficiency of laborers and the reduction of jar is particularly noticeable in the use of warehouse and factory hand trucks provided with springs.

## DOUBLE-ANGLE COLUMNS*

By EDMUND B. LA SALLE†

A common type of column used for supporting water tanks is that built up of two angles, apex to apex, tied together at various points by a plate or angle, four such built-up columns being used to support the tank. These double-angle columns make a very simple construction, for but little shop work is

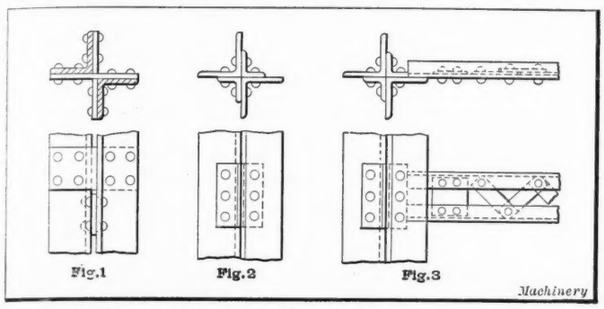



Fig. 1. Cross-plate Tie for Double-angle Column. Fig. 2. Angle Tie for Double-angle Column. Fig. 3. Method of Butting Struts to Angle Tie on Double-angle Column

required. Not only are they used for elevated water-tank construction, but they are also equally well adapted to numerous lines of general structural work.

The two angles of a column are tied together, as indicated in Fig. 1, by two short cross-plates riveted to the angles, or as illustrated in Fig. 2, by two short pieces of angle about half the size of those used in the column. These ties are located from two to four feet apart, depending on the size of the angles to be tied together.

The cross-struts between the members are located a distance apart depending upon the size of angles and the method of tying; these two factors determine the radius of gyration. The table in the Data Sheet Supplement, "Properties of Double Angle Columns," gives all the data necessary to determine the size of angles for a given strut spacing, or *vice versa*.

These data may be used with either of the formulas given, the strength per unit of cross-sectional area in the case of the Carnegie equation being $17{,}100 - 57\frac{L}{R}$, and in the Maintenance of Way specifications recommended for railway work $16{,}000 - 70\frac{L}{R}$; in both cases $L$ is the length between struts in inches, and $R$ the least radius of gyration. The accompanying table "Unit Strength Columns", reduces the necessary column calculations, the unit strength being readily determined when the slenderness factor $\frac{L}{R}$ is known. In the Carnegie formula, when this factor is below 90 it is customary to assume a unit strength of 12,000 pounds per square inch.

In the construction employing short tie plates, it is necessary to make special connections for the struts by means of attached gusset plates. In the type where the angle tie is used, the inner tying angle, as shown in Fig. 3, is milled along one edge in order to form a good bearing support for the end of the strut, which is also milled.

Double-angle columns are preferred to the latticed channel column on account of their openness which leaves them clear at all times for inspection and painting. Another decided advantage is the low cost of construction as compared with columns of other types.

* * *

## ENTERING WEDGE FOR METRIC SYSTEM

The annular ball bearings made abroad, which are being so largely used in America in automobiles and other machinery, are made to metric measurements. As a result the users must provide metric gages and work to them when fitting the bearings to their machines. If the metric system has inherent advantages, the use of it in this work should to some extent demonstrate the fact to American shop managers. It will familiarize draftsmen, toolmakers and machinists with the system, removing the distrust of something unknown, and thus place it on a parity with the English or inch system of measurement.

UNIT STRENGTH COLUMNS

| $17100 - 57\frac{L}{R}$ | | | | | | | | $16000 - 70\frac{L}{R}$ | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\frac{L}{R}$ | Str'gth | $\frac{L}{R}$ | Str'gth | $\frac{L}{R}$ | Str'gth | $\frac{L}{R}$ | Str'gth | $\frac{L}{R}$ | Str'gth | $\frac{L}{R}$ | Str'gth | $\frac{L}{R}$ | Str'gth | $\frac{L}{R}$ | Str'gth | $\frac{L}{R}$ | Str'gth | $\frac{L}{R}$ | Str'gth |
| 91 | 11913 | 121 | 10203 | 151 | 8493 | 181 | 6783 | 41 | 13130 | 71 | 11030 | 101 | 8930 | 131 | 6830 | 161 | 4730 | 191 | 2630 |
| 92 | 11856 | 122 | 10146 | 152 | 8436 | 182 | 6726 | 42 | 13060 | 72 | 10960 | 102 | 8860 | 132 | 6760 | 162 | 4660 | 192 | 2560 |
| 93 | 11799 | 123 | 10089 | 153 | 8379 | 183 | 6669 | 43 | 12990 | 73 | 10890 | 103 | 8790 | 133 | 6690 | 163 | 4590 | 193 | 2490 |
| 94 | 11742 | 124 | 10032 | 154 | 8322 | 184 | 6612 | 44 | 12920 | 74 | 10820 | 104 | 8720 | 134 | 6620 | 164 | 4520 | 194 | 2420 |
| 95 | 11685 | 125 | 9975 | 155 | 8265 | 185 | 6555 | 45 | 12850 | 75 | 10750 | 105 | 8650 | 135 | 6550 | 165 | 4450 | 195 | 2350 |
| 96 | 11628 | 126 | 9918 | 156 | 8208 | 186 | 6498 | 46 | 12780 | 76 | 10680 | 106 | 8580 | 136 | 6480 | 166 | 4380 | 196 | 2280 |
| 97 | 11571 | 127 | 9861 | 157 | 8151 | 187 | 6441 | 47 | 12710 | 77 | 10610 | 107 | 8510 | 137 | 6410 | 167 | 4310 | 197 | 2210 |
| 98 | 11514 | 128 | 9804 | 158 | 8094 | 188 | 6384 | 48 | 12640 | 78 | 10540 | 108 | 8440 | 138 | 6340 | 168 | 4240 | 198 | 2140 |
| 99 | 11457 | 129 | 9747 | 159 | 8037 | 189 | 6327 | 49 | 12570 | 79 | 10470 | 109 | 8370 | 139 | 6270 | 169 | 4170 | 199 | 2070 |
| 100 | 11400 | 130 | 9690 | 160 | 7980 | 190 | 6270 | 50 | 12500 | 80 | 10400 | 110 | 8300 | 140 | 6200 | 170 | 4100 | 200 | 2000 |
| 101 | 11343 | 131 | 9633 | 161 | 7923 | 191 | 6213 | 51 | 12430 | 81 | 10330 | 111 | 8230 | 141 | 6130 | 171 | 4030 | 201 | 1930 |
| 102 | 11286 | 132 | 9576 | 162 | 7866 | 192 | 6156 | 52 | 12360 | 82 | 10260 | 112 | 8160 | 142 | 6060 | 172 | 3960 | 202 | 1860 |
| 103 | 11229 | 133 | 9519 | 163 | 7809 | 193 | 6099 | 53 | 12290 | 83 | 10190 | 113 | 8090 | 143 | 5990 | 173 | 3890 | 203 | 1790 |
| 104 | 11172 | 134 | 9462 | 164 | 7752 | 194 | 6042 | 54 | 12220 | 84 | 10120 | 114 | 8020 | 144 | 5920 | 174 | 3820 | 204 | 1720 |
| 105 | 11115 | 135 | 9405 | 165 | 7695 | 195 | 5985 | 55 | 12150 | 85 | 10050 | 115 | 7950 | 145 | 5850 | 175 | 3750 | 205 | 1650 |
| 106 | 11058 | 136 | 9348 | 166 | 7638 | 196 | 5928 | 56 | 12080 | 86 | 9980 | 116 | 7880 | 146 | 5780 | 176 | 3680 | 206 | 1580 |
| 107 | 11001 | 137 | 9291 | 167 | 7581 | 197 | 5871 | 57 | 12010 | 87 | 9910 | 117 | 7810 | 147 | 5710 | 177 | 3610 | 207 | 1510 |
| 108 | 10994 | 138 | 9234 | 168 | 7524 | 198 | 5814 | 58 | 11940 | 88 | 9840 | 118 | 7740 | 148 | 5640 | 178 | 3540 | 208 | 1440 |
| 109 | 10887 | 139 | 9177 | 169 | 7467 | 199 | 5757 | 59 | 11870 | 89 | 9770 | 119 | 7670 | 149 | 5570 | 179 | 3470 | 209 | 1370 |
| 110 | 10830 | 140 | 9120 | 170 | 7410 | 200 | 5700 | 60 | 11800 | 90 | 9700 | 120 | 7600 | 150 | 5500 | 180 | 3400 | 210 | 1300 |
| 111 | 10773 | 141 | 9063 | 171 | 7353 | 201 | 5643 | 61 | 11730 | 91 | 9630 | 121 | 7530 | 151 | 5430 | 181 | 3330 | 211 | 1230 |
| 112 | 10716 | 142 | 9006 | 172 | 7296 | 202 | 5586 | 62 | 11660 | 92 | 9560 | 122 | 7460 | 152 | 5360 | 182 | 3260 | 212 | 1160 |
| 113 | 10659 | 143 | 8949 | 173 | 7239 | 203 | 5529 | 63 | 11590 | 93 | 9490 | 123 | 7390 | 153 | 5290 | 183 | 3190 | 213 | 1090 |
| 114 | 10602 | 144 | 8892 | 174 | 7182 | 204 | 5472 | 64 | 11520 | 94 | 9420 | 124 | 7320 | 154 | 5220 | 184 | 3120 | 214 | 1020 |
| 115 | 10545 | 145 | 8835 | 175 | 7125 | 205 | 5415 | 65 | 11450 | 95 | 9350 | 125 | 7250 | 155 | 5150 | 185 | 3050 | 215 | 950 |
| 116 | 10488 | 146 | 8778 | 176 | 7068 | 206 | 5358 | 66 | 11380 | 96 | 9280 | 126 | 7180 | 156 | 5080 | 186 | 2980 | 216 | 880 |
| 117 | 10431 | 147 | 8721 | 177 | 7011 | 207 | 5301 | 67 | 11310 | 97 | 9210 | 127 | 7110 | 157 | 5010 | 187 | 2910 | 217 | 810 |
| 118 | 10374 | 148 | 8664 | 178 | 6954 | 208 | 5244 | 68 | 11240 | 98 | 9140 | 128 | 7040 | 158 | 4940 | 188 | 2840 | 218 | 740 |
| 119 | 10317 | 149 | 8607 | 179 | 6897 | 209 | 5187 | 69 | 11170 | 99 | 9070 | 129 | 6970 | 159 | 4870 | 189 | 2770 | 219 | 670 |
| 120 | 10260 | 150 | 8550 | 180 | 6840 | 210 | 5130 | 70 | 11100 | 100 | 9000 | 130 | 6900 | 160 | 4800 | 190 | 2700 | 220 | 600 |

* With Data Sheet Supplement.
† Address: 159 Harrison St., Batavia, Ill.

# THE PRINTING PRESS IN THE DRAFTING ROOM

By H. W. WEISGERBER*

As a mechanical appliance to relieve manual labor and at the same time to increase the output a million-fold, the printing press stands as the oldest of the so-called "modern" inventions. By its aid, mankind has advanced farther in the arts and sciences, and toward universal education, during the last four hundred years than in all the centuries preceding.

Old as the printing press is, it is strange that there are so many concerns employing high-priced draftsmen, who still adhere to the older art of hand-lettering for printing titles on drawings; these firms spend enough in that way every year to purchase a title printing outfit. The title printing outfits have been on the market for more than a decade; yet, it is surprising to see the number of blueprints coming from all over the country that have hand-lettered titles. Why is it? The only reason the firms do not use presses, it seems to me, is that they imagine an outfit too costly, or that it would require a high-priced printer to do the work. This is not so. There are hundreds of little boys every year who are presented with toy printing presses and who have no further instruction than a few simple directions; yet, these little fellows do respectable jobs. Therefore, it is unnecessary to have had a printing office experience; besides, some of the printers' "tricks" are done away with or reversed. In title printing it is only necessary to change certain lines, so that after a title is once put into form, that form remains standard, and it is only necessary to change the scale, date, and size or name of machine. The firm's name, the spacing, etc., remains as it is. The work can be done rapidly; the writer has printed titles at an average rate of a minute for each. Some draftsmen require that much time to rule off the space when getting ready to letter by hand.

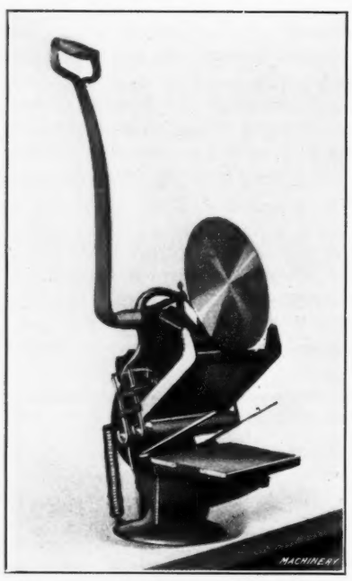



Fig. 1. Printing Press suitable for Title Printing in the Drafting Room

There are many other uses for a title press, such as printing shipping tags, index cards, shop cards, shop notices, and job or order numbers on blueprints going into various departments. There are also many small jobs that would never be sent to a regular printer on account of the cost, that can be done in this way at the cost of but a few cents, the price of a man's time. A press soon pays for itself where many tracings are made; no extra help need be hired, for the blueprint department does the work.

26-52x36 CROSS COMP. L. P.
BUCKEYE ENGINE CO., SALEM, O.
APR., 13, 1907 SCALE 6 IN. TO 1 FT
147 F 86

Fig. 2. Example of Title Printing. Forty-five Titles were Printed in Forty-two Minutes. The Drawing Number was changed for every Title

The press is, perhaps, the most expensive part of the outfit. Two, three or four fonts of type are all that are necessary to start with; they should, however, all be of Gothic face, for Roman face type is too fine to reproduce well in blueprinting, and the "tails" wear off too soon. Then, there are a few essentials such as slugs, leads, wood furniture, an extra chase or two, quoins, ink and the type cases or a small type cabinet; these are enough to begin with, and more can be added as the work for which the press is used, grows. The accompanying illustrations, if compared with the lettering of the average draftsman or tracer, show the superiority of the printed title.

The essential part of an outfit is the press. It should be strong and durable, convenient and easy of operation. While a good press is expensive to start with, it will last a lifetime and thus pay for itself, whereas a cheap one might soon become useless. A small press can be bought for one-third the price of one twice as large; yet, it is better to buy one that is larger than the titles for which it is intended, for it will be found that other printing can be done on it; do not economize on the press.

ORDER NO. 6137.
20x42 BUCKEYE ENGINE,
ORDERED BY
Robinson, Cary & Sands Co., St. Paul, Minn. for the
SHEVLIN-CLARKE CO., Ltd. FT. FRANCIS, ONTARIO, CANADA.
BUCKEYE ENGINE CO., SALEM, OHIO.
APR. 13, 1911 SCALE ½ IN TO 1 FT
45 C 74

Fig. 3. Example of Title Printing

There are numerous small "job presses" on the market, and doubtless one make is as good as another, and for equal quality, the prices are about the same. The Golding Mfg. Co., of Franklin, Mass., has in its "Official Printing Press" for drafting-room use, a press that meets all the requirements for a title press. It has a stationary, level platen, free from moving or stationary parts at the sides, so that large or small tracings can be printed with equal ease, as the tracings lie flat while receiving the impression. This press is made in two sizes, No. 9 with a 6- by 9-inch chase, and No. 12 with an 8- by 12-inch chase; the prices are $45.00 and $80.00 respectively.

ORDER NO. 5907.
18 x 24 S. A. T. Natural Gas Engine,
ORDERED BY
THE QUEEN CITY PRINTING INK COMPANY,
Bert L. Baldwin & Co., Consulting Engineers, Cincinnati, Ohio.
BUCKEYE ENGINE CO., SALEM, OHIO,
JUNE, 25, 1909. SCALE ½ IN. TO 1 FT.
36 C 23

Fig. 4. Another Example of Title Printing

This company also makes the regular "Official Jobbing Presses" with the moving platen, ranging from the No. 1, 3- by 4½-inch chase, at $10.00, to the No. 12, 8¼- by 12½-inch chase, at $60.00. Through mistake, our company purchased the regular No. 4 press; but by a clever arrangement whereby the two front adjusting screws were replaced by studs, and a steel bar placed across, the press was clamped to the table with the bottom of the platen resting on the table top, and so we have a "level platen" press with the foot of the press doing the "swinging."

Any make of standard type can be used. The type can be secured through the Golding Mfg. Co., Thos. E. Kennedy & Co., of Cincinnati, and numerous other firms. Besides the type and the case for each font of type, an assortment of accessories is necessary, such as two-point leads, for spacing between lines. The "point" is the unit of measurement. All type bodies are cast on the "point" system. Four "points" equal about one-sixteenth inch in thickness. The leads can also be had in other thicknesses, but they are not necessary, for several two-point leads can be used. Leads cost about 16 cents per pound. Instead of thicker leads, the so-called

* Address: 56 Chestnut St., Salem, Ohio.

"wood furniture" is much cheaper, as well as lighter in weight. Instead of buying much high-priced lead, buy, therefore, an assortment of the smaller thicknesses of "wood furniture." It comes in about three-foot lengths, and can be cut to proper size. Each size is sawed to equal thickness and all thicknesses are of an equal width. They are made of seasoned and oiled cherry wood and cost from two to ten cents per yard, according to thickness. A pair of tweezers and bodkin are almost necessary, especially if small type is used; a combined bodkin and tweezers costs from forty cents to a dollar each; while a wooden handle bodkin costs ten cents.

An imposing stone on which to place the "form," as the chase with its type is called, is necessary; it usually consists of a white marble or metal slab, slightly larger than the chase. All of the type setting for titles is done on the stone instead of using a printer's "stick." As a general thing there are enough of the smaller spaces and "en" quads in each font of type, but a scarcity of the one-, two-, and three-"em" quads for title work; so, in order to save time in picking up a number of the smaller ones, and to have all that one may need, it is best to buy an extra font of quads and spaces, which cost about 65 cents per font for the smaller sizes. Likewise the fractions are an unknown quantity in the small type, and they are useful, especially in the line of the title for the scale of the drawing; they, too, are quite inexpensive, costing about 50 cents per font.

If a few odds and ends in the line of letters or figures in large characters, brass rule, leaders, leads or slugs, are needed, they can be procured from local printers, who usually have an abundance of such supplies. Where several sizes of type are used in a title it will be found that there are characters enough so that several chases may be set up, thus avoiding "dropping" an entire form to set up another.

Type prices vary according to their size. A font of 20-A (meaning that each font has 20 capital letter "A's," and other letters in proportion to their use), 10-point Gothic costs $1.00, while a font of 9-A, 20-point Gothic costs $1.25; these prices are for all-capital-letter fonts, with figures, points, spaces, and quads. The same size type in capital and small letters, called upper and lower case, costs over three dollars a font. These prices are from the catalogue of Barnhart Bros. & Spindler's, Chicago, Ill. Do not be misled into buying fancy letters. The large-faced, plain and substantial Gothic type, in broad or condensed shapes, will wear longer and give better blueprint reproductions than the hair line Roman or other fancy styles.

Printer's ink will not work on tracing cloth; so a tracing cloth ink must always be used. The Queen City Printing Ink Co., of Cincinnati, Ohio, makes a satisfactory ink, at $3.00 per pound. It is not necessary to buy everything to be found in a printer's supply catalogue. It is surprising with what few things title printing can be done.

A summary of the outfit is as follows: Press; one type case for each font of type; type; quoins and key; imposing stone; ½ pound of ink; about 10 pounds 2-point leads; extra spaces and quads; wood furniture; extra fractions, if necessary; extra figures; bodkin and tweezers.

* * *

One of the most common misconceptions of the principles of apparatus is perhaps that of the way an electric dynamo generates electricity. Probably one-half the men who pretend to know something about machinery, but who have really never studied it, imagine that electricity is generated by the friction of the brushes on the commutator. They have the common knowledge of the generation of static electricity by rubbing a glass rod with a silk handkerchief or by the brushes of a Wimshurst machine, and jump at the conclusion that the mighty generators in the power stations work on the same principle.

* * *

An experimental road covering a stretch of 6900 feet is being constructed near New Eltham in England. The experimental road consists of 23 sections, each 300 feet long, and on each section a different method of construction is employed so that after a certain period of use it will be possible to determine the relative advantages of the various types of road.

## BRIQUETTING OF METAL BORINGS*

One of the latest developments in the metal industry in connection with the utilization of metallic waste is the process of briquetting under enormous pressure without the use of a binding medium. The process was orginated by Arpad Ronay, of Budapest. He employed extreme pressure, allowing a sufficient time to permit the individual particles to come into intimate contact, excluding thereby spaces filled with air which would have a tendency to weaken the bond. When metal particles, as well as ores or other fine materials, are subjected to ordinary pressures, sufficient air is entrapped to cause trouble when the briquettes are heated; the air expands, thereby breaking the briquette.

When the writer was first asked to investigate the process professionally for American interests, and before going to Europe, he melted one of the German cast-iron boring briquettes in his cupola. It was found that the briquetted borings melted similarly to pig iron, and the briquette maintained its shape until the final softening and dropping to the bottom. A visit to the several briquetting installations in Europe showed this industry to be in a flourishing condition and ten plants are now in operation.

The process may be briefly described as follows: Cast iron, steel, brass, bronze, aluminum, copper chips, borings, filings and metallic slimes after drying coal, graphite, ore, flue dust, etc., can be satisfactorily briquetted. Borings, before being dumped into the hopper above the press, have the dust and dirt removed by an exhaust fan. This operation likewise removes rust which has become loosened by the rubbing of the particles against each other during transit, and the quality of the briquette is thereby greatly improved. In the case of steel turnings, these are passed through a set of disintegrating rolls to reduce their bulk. After cleaning, the borings are passed over a magnetic separator to remove any brass from the iron. The cleaned and separated borings are then delivered to the feed hopper of the press. The bunker is filled with borings by a bucket elevator. The borings flow by gravity into the plunger of the press and then into the die. As the plunger descends, the borings receive their first compression. The air is forced out as the borings are compressed, the separate particles curling into each other. The partially completed briquette in the die is then carried by the revolving table to the next stop, where plungers, both from above and below, apply pressures of 35,000 pounds per square inch. The die containing the briquette is free to move up or down at this point, permitting the compressed material freedom to adjust itself. When the pressure is released, the revolving table makes another turn and the die with the finished briquette, which is slightly conical in shape, is passed under another plunger which forces the briquette out of the die and onto a conveyor by which it is carried away from the machine. All of these movements are entirely automatic, the operation of the press being in charge of one man, a second carrying away the briquettes, while a third has charge of filling the hopper with borings. The briquettes become quite hot during this operation.

A large press installed in a Chemnitz plant has a capacity of six tons per hour, and the cost of briquetting, exclusive of royalty, has been reduced to about 50 cents per ton. The cost of a press of this size with conveying apparatus and all accessories, is about $35,000.

The use of briquettes in the cupola is similar to the use of pig iron and heavy scrap, and although the briquettes, in spite of the enormous pressure to which they are subjected, are not as solid as pig iron, melting somewhat more rapidly, their handy shape and weight makes them an ideal cupola charging and melting material. In Germany these briquettes are actually sold at pig iron prices, and at the Borsig Locomotive Works, the regular charges for steam and gas engine cylinders, refrigerating machinery castings, and castings for hydraulic machinery, air compressors, superheated steam and steam turbine apparatus, contain 40 per cent of briquettes.

* * *

A little knowledge may be a "dangerous thing," but it is almighty handy on occasion.—*Exchange.*

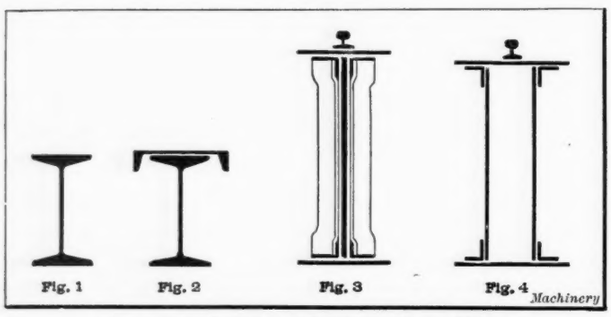
* Abstract of a paper by Mr. Richard Moldenke, read before the Pittsburg convention of the American Foundrymen's Association.

# POINTS IN CRANE CONSTRUCTION AND DESIGN*

By OTTO ABDT

In the following article are given a number of suggestions for the design of overhead cranes. It has not been intended by the writer to present a complete treatise on crane design, or even on crane girder design, but merely to call the attention of designers to some points in crane design which may be useful to them in their work.

In Fig. 1 is shown the common I-beam girder section used in single- and double-girder hand-power and light-power type of crane bridges for short spans. In Fig. 2 the same type of




Figs. 1 to 4. Examples of Sections of Crane Girders

girder is shown reinforced by a channel for longer spans. Figs. 3 and 4 show sections commonly used for all-power cranes of spans above 25 feet and above three tons capacity. As regards Fig. 1, there is nothing special to note, except that the beam should withstand the load with a factor of safety of 6 for power, and at least 4 for hand-power devices, and that the length of span in any case should not be more than 20 times the flange-width of the beam.

In Fig. 2 the channel is added to increase the transverse stiffness of the beam and also the compressive strength of the top flange. However, this addition reduces the deflection very little, and is a poor substitute for the designs shown in Figs. 3 and 4, unless a channel of suitable section is added on the lower flange, which, again, under certain conditions, brings forth another consideration in the liability of the web to cripple.

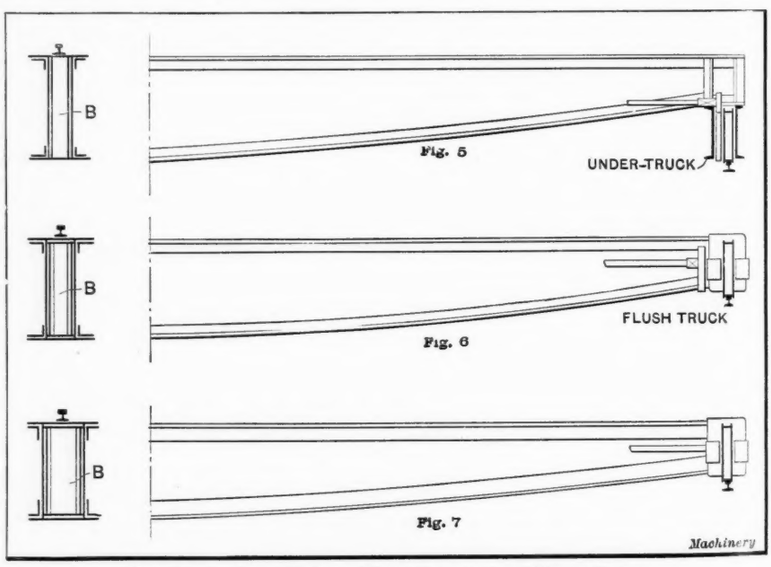
Fig. 3, or the single-web girder, is an improvement on the girders previously mentioned, and is often placed on hand-power cranes of unusual span and capacity. These girders are generally provided with a rail for the trolley, the section of which is seldom, if ever, considered in the strength of the girder. Fig. 4—the box type—is the type of girder for indoor power traveling cranes, and is almost universally used in this country.

Figs. 5, 6 and 7 are sections and outline elevations of three girders from cranes of the same capacity and span but of different design. The illustrations are made to about the same scale and thus show the variation in proportions of the top and bottom chords to the length and width between webs. These girders all have a factor of safety of about 6, but they differ materially in every other respect.

In Fig. 5 the diaphragms or separators *B* are standard channels, riveted to the webs and supporting the top plate at intervals, thus acting as support to the bridge rails and also imparting stiffness to the webs. In fact, they act as posts and ties, and add generally to the stiffness of the girders, both from the standpoint of deflection and transverse strains. The riveting of the angles along the sides of this girder varies in pitch from two and one-half inches at the ends, to five inches in the center, on both the top and bottom members. The web splice plates are riveted in a single row, spaced at three inches, and take care of the shear. The rails are of the same size as in Fig. 7. The top plate is spliced with a plate on each side of the rail, and one under the top plate between the webs, thus allowing the rail to rest on the top plate proper. Sufficient riveting and plate are allowed to take care of the compression in this member. The bottom chord is also economically spliced, on the strong side, and allowance is made for rivet holes in the plate, etc. It is also notable that the web splice is in the center. The top chord splice is near one end and the bottom chord splice near the other, thus "breaking" splices.

In Figs. 6 and 7 similar methods of construction and engineering are used. The diaphragms, stiffeners or separators are built up of plate and angles. The web plates and diaphragms lack about one-quarter inch of touching the top and bottom plates. Thus a heavy plate is required to support the rail. In Fig. 7 there is an extremely heavy top plate, and the design is extremely wide between the webs, but it seems as if this elaboration is rather extreme and expensive. These girders are closely riveted, a spacing of 3 inches being the maximum.

Probably no two designers of crane girders agree except in a few details of their construction, and yet their variations are based on logical conclusions, which seem to be correct when taking account of their separate views. One builder investigates his customer's needs, and if the crane is only to be used under ordinary service (and to full capacity only occasionally), the girder is designed for full load stress, including live and dead vertical loads, but the side strain is not considered for full loads. As the handling of a full load will, in all probability, occur very seldom, it is assumed that the operator will be unusually careful in such a case and the side strain will then easily be taken care of by the stiffen-




Figs. 5 to 7. Crane Girders of Same Capacity but Different Design

ers, diaphragms, etc. Another considers full loads at full speed with wheels locked and skidding taking place at a speed of 300 feet per minute, for which he adds a side strain of 20 per cent of the vertical stresses. The proportions of his girders are such that they will approximately double the strength of the former for vertical loading, and this design is applied to all cranes. The usual stiffeners are added, but not considered in the calculations. The first-mentioned designer would almost duplicate the latter's girder under conditions of severe service, and although his method of handling ordinary cases may seem somewhat risky, fifteen years of this economical practice have demonstrated from a manufacturing and practical standpoint that this method of girder design is satisfactory.

* For additional information on this and kindred subjects, see the following articles previously published in MACHINERY: May, 1911, "Rail Fastenings for Crane Runways"; September, 1910, "Power Required to Drive Cranes"; September, 1909, "Calculation of Pillar Cranes". See also the note accompanying the last mentioned article, and MACHINERY's Reference Book No. 23, "Crane Design"; No. 47, "Electric Overhead Cranes"; and No. 49, "Girders for Electric Overhead Cranes".

### Miscellaneous Hints on Crane Design

A bridge-travel motor should not be placed at the center of a crane girder, because the overhang and vibration from it causes undesirable stresses. It should be placed near the end and be accessible from a platform which would also be useful for overhauling the trolley. A foot-walk across the bridge is handy for oiling shaft bearings, and also the axles on the end of the crane opposite the operator's cage.

There is always deflection in a girder and consequently bending of the cross-shaft, thus causing considerable loss of power in the operation of the crane. Hence, a system of flexible joints would increase the efficiency and eliminate some of the gear troubles.

Crane bridge and trolley wheels give better service if they have chilled cast-iron treads, than they do if made of cast steel, because, owing to the uncertainty of cast steel, a hole very near the surface may not be noticeable until

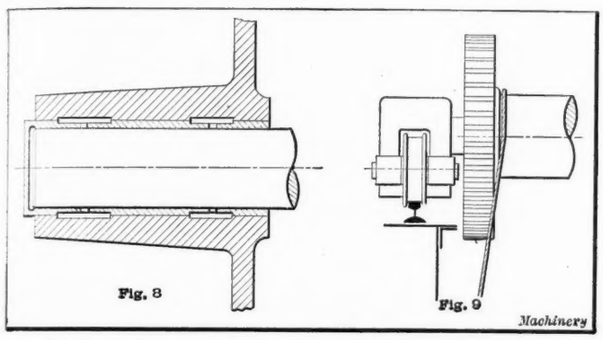



Fig. 8. Dust-proof Bushing for Bearings

Fig. 9. Showing Danger of Gear Teeth Severing the Cable

the wheel has developed a flat spot or two in service. This is a case comparatively rare with cast-iron chilled tread wheels.

Cross-shafting can be made from cold-rolled stock, if babbitted bearings are used, and is just as serviceable as turned shafting. Rails should not be riveted to girders, as they sometimes prove defective, and are then quite difficult to remove and replace.

There is nothing gained by close riveting in a girder; the conditions should be examined, and a spacing determined according to some accepted formula such as given in handbooks. Webs closely placed, with liberal overhang of top and bottom plates, will guard service wires from contact with the hoisting ropes. This condition is aided by using unequal leg angles with long legs in the horizontal plane, which again increases the strength and stiffness of the girders by throwing out the center of gravity of the angles in all directions.

The selection and placing of electrical apparatus is mainly a matter of opinion, but where the resistance is placed under the cage floor, the air circulation is better and more room is left in the cage for the operator; it also facilitates wiring. By covering and using hinged openings for the passage of air and a grating in the bottom of the cage, the operator may be protected from heat in the summer and cold in the winter, if the crane is in constant use.

A reliable stop for preventing a crane from hoisting too far, and yet not prevent lowering, is essential, and should never be overlooked. Steel hoisting ropes are preferable to chains, as a rope gives warning of wearing out, and accidents may be prevented by buying a new rope. A chain requires occasional annealing, and failure to attend properly to this matter means danger, to say nothing of the additional clumsiness, noise and extra cost for chain trolleys. A crane trolley should always be equipped with electrical as well as mechanical brakes, and each should be of sufficient capacity to stop and hold the full load in event the other fails to work. The strength of the gears should be ample. A wide-faced and moderate-pitch gear has many advantages over a coarse-pitch and comparatively narrow-faced one.

The ideal place for the drum gear is at the center of the drum. A band could be turned larger in diameter than the drum face, and a rim gear shrunk on and properly keyed. When drum gears are placed at the end of the drum, the torque produced constitutes an undesirable condition. If the gear is keyed to the shaft, the difficulties are multiplied several times, and a shaft of abnormal diameter is required to withstand the strain. Besides, when the loads are down and are swinging in the direction of the crane travel, it has happened that the teeth of the drum gear have severed the cables, as indicated in Fig. 9.

Special attention should be given to the bearings. A pressure of about eight hundred pounds per square inch of projected area seems to be a fair average in general practice, but a decrease in this allowable pressure will certainly increase the life of the crane and cause less expense for renewals, and the need of an adjustable bearing would be minimized. A good bronze alloy is preferable to the soft molded bearings; it should be well fitted and scraped.

Special care should be taken in providing as nearly automatic lubrication as possible. Cranes are the most neglected of any expensive machines, mostly because the oil holes are either concealed or require an acrobat to reach them. This most important feature should be handled properly by the designer. A ring-oiled bearing for the cross-shaft and liberal waste oilers for the axles require but occasional attention. These devices, however, do not seem to work on the trolley, and a gear case is relied upon to do the oiling, by being partially filled, the gears being expected to splash sufficiently to supply the bearings with oil. The result is the oil is beaten over and over again, is exposed considerably to the air in this process, and consequently thickened. Sometimes grease cups are supplied which have the disadvantage first mentioned. By copying the idea of automobile lubrication, central lubricators or pots could be used and copper tubing run from them to each bearing, insuring lubrication, and eliminating a good deal of dissatisfaction among purchasers. As dust sometimes ruins bearings, a bushing such as shown in Fig. 8 has advantages.

A sliding collector shoe seems to be a very poor means of gathering current. No doubt the contact is more perfect and better than when using the collector wheel, but we have yet to learn of an instance where the trolley wheel did not do the work it was intended for, and it will outlast the shoes several times over.

Prospective crane buyers should consider their crane proposition before constructing the runways in new buildings. They could thereby save considerable by having runways constructed for cranes of under- or through-truck type, as shown in Fig. 5. This makes the runway considerably lower, but at the same time allows a maximum hoisting range. The crane mechanism is not so cramped, and, in general, a far superior crane is obtained. The extra cost of a crane of this type depends on the maker; it would be reduced somewhat by the difference in cost of the runway for under-truck or flush-truck (Fig. 6) construction.

* * *

Many a machinist has found out how difficult it is to cut quick-pitch worms on an engine lathe not designed for such work. The lead-screw has to be geared up to run several times faster than the spindle, the result oftentimes being that the change gears will not stand the strain. A common "stunt" is to mount a belt pulley on the lead-screw beside the change gear, belt it to the countershaft and drive the spindle through the change gears. The power required for the cut is less than that needed to overcome the friction of the screw and carriage. A similar condition is found on the milling machine when milling worms of fine pitches using the common form of dividing head. In this case the difficulty, however, is to rotate the work rapidly enough. Suppose, for example, an 8-pitch worm is to be milled, using the common dividing head and vertical attachment. The table screw is 4-pitch and in moving the table one inch it turns four times, but the index head must turn eight times and the worm driving it $40 \times 8 = 320$ times. To overcome this difficulty, the Kempsmith Milling Machine Co., Milwaukee, Wis., provides means for dropping out the worm and driving the dividing head spindle direct from the table screw. In the foregoing example the ratio of change gears would be 2 to 1 instead of 80 to 1.

# USE OF THE SINE BAR FOR MEASURING ANGLES

By WILLIAM S. ROWELL*

The impossibility of measuring angles accurately with protractors has led to the use of other methods, when close measurements are necessary. The sine bar described in the following has been found convenient by the writer and may be of interest to others. A sine bar of the dimensions given at *A* in Fig. 1 was used. A longer bar tends to give greater accuracy of measurement, but may at times be less convenient. Ten inches between the plug centers would give a dimension easily reduced to corresponding sine. This bar is made of tool

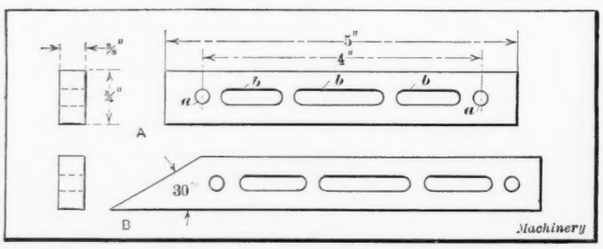



Fig. 1. A, Sine Bar for Ordinary Work; B, Sine Bar for Obtaining Angles in Difficult Places

steel, hardened and ground all over, and is made as straight, parallel, and with angles as near ninety degrees as is possible The ¼-inch lapped holes *a* should be at right angles to the sides of the bar and exactly 4 inches from center to center. The slotted openings *b* are for convenience in clamping only, and should be made of a width most suitable for that purpose. The lapped holes in the bar are superior to permanent projecting plugs, as this allows the bar to be used for other purposes, where projecting plugs would be in the way.

The bar shown at *B* in Fig. 1 is an improvement, one end being formed to a 30-degree angle, making it easily inserted in narrow openings. (See Fig. 5.) The many uses of such a bar will be suggested by the following. The sine bar is always used in a measurable relation to a true surface, such as a surface plate. The distance from the center of one plug

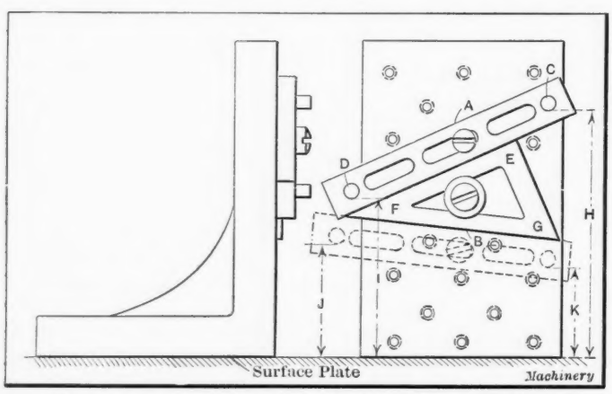



Fig. 2. Application of the Sine Bar for Measuring a Small Angle

to the center of the other is always considered a radius. To find the angle *EFG*, Fig. 2, clamp the sine bar *A* in contact with one side of the angle *B* as shown, and then obtain the heights of plugs *C* and *D* from the surface plate. Now shift the sine bar to the opposite side of the angle *B*, and again find the heights of the plugs.

The difference between the heights of the plugs obtained at each setting of the bar is 4 times the sine of the unknown angle. Hence this dimension divided by 4 gives the sine of the angle. By referring to a table of sines, the angles can be found; the sum of the two angles gives the angle *EFG*.

For example, let distance *H* equal 4.5803 inches and *I* equal 2.9375 inches. Subtracting *I* from *H*, we have 4.5803—2.9375 = 1.6428 inch. Now shift the sine bar to the position shown by the dotted lines in Fig. 2, and let distance *J* equal 2.0879 inches, and *K* equal 1.6875 inch. Subtracting *K* from *J*, we have 2.0879 — 1.6875 = 0.4004 inch. Dividing 1.6428 and 0.4004 by 4, we get 0.4107 and 0.1001 as sines of the angles. Referring to a table of sines, we find that 0.4107 is the sine of 24 degrees 15 minutes, and 0.1001 the sine of 5 degrees 45 minutes. The sum of these two angles is 30 degrees, which is the angle *EFG*.

Some may prefer to carefully set one side of the angle *B* to be measured, parallel with the surface plate, as shown in Fig. 3, and thus obtain the plug heights but once; however, as a small angle is more accurately found by the foregoing method than by having one side horizontal this method is given.

At *A*, in Fig. 4, is shown a small countersink gage which defied measurement by any other means. As the shank *a* was not true with the gage it could not be used for setting to obtain the desired angle. The method used in setting the piece is shown in Fig. 4, where the lower side *b* of the angle

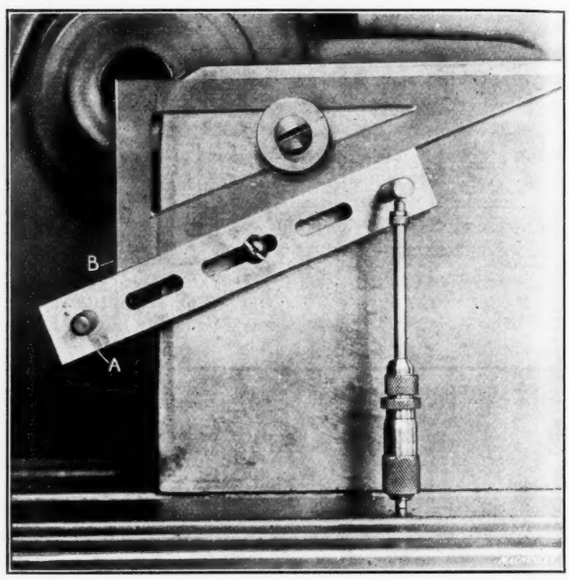



Fig. 3. Obtaining an Angle when One Edge of the Work is set Parallel with the Milling Machine Platen

is set parallel with the surface plate by a height gage, the finger surface of which is reduced to about 0.020 inch. The gage *A* was projected beyond the angle-plate to get the best light conditions. Fig. 5 shows a case where the improved sine bar shown at *B* in Fig. 1, is used advantageously.

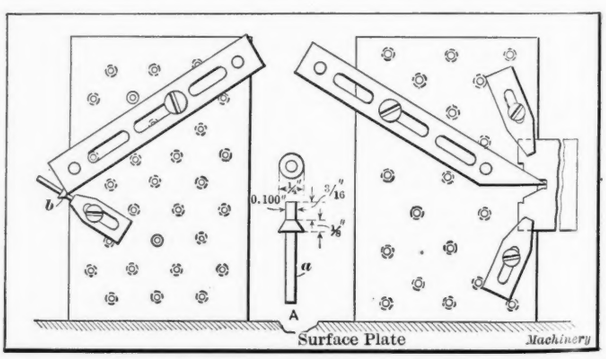



Fig. 4. Obtaining the Angle of a Small Gage. Fig. 5. Application of the Sine Bar shown at B in Fig. 1

Other numerous uses of the sine bar for setting up work will readily suggest themselves. It may also be set in the correct relation to a straightedge and used as a gage for taper plugs, etc.

* * *

A steel mill, recently put into operation for making seamless tubing, was equipped with twenty-six straightening machines. Not long after it started into operation an inventor of a straightening machine demonstrated that his invention was superior to those in use, and the twenty-six machines were displaced by two of the improved machines. This is but one example of the scrapping of machinery that is constantly being done in the effort to secure higher efficiency.

* Address: Care of Hooven, Owens, Rentschler Co., Hamilton, Ohio.

# FOUNTAIN PEN MANUFACTURE*

## MAKING L. E. WATERMAN GOLD PENS

By DOUGLAS T. HAMILTON†

The life of the ordinary steel pen is of short duration as compared with the gold iridium-tipped pen point used in Waterman's Ideal fountain pens. The reason for this is that gold does not corrode or oxidize like steel, and that its wearing qualities are increased by iridium, which is the hardest known metal. Other interesting facts concerning the manufacture of this fountain pen, especially the gold pen point, and the ink used in it, are given in the following article.

### Alloying and Melting the Gold for Pen Points

The gold for the pen point is received from the United States assay office in bricks 24 carats fine, measuring about 2½ inches long by 1½ inch wide by ¾ inch thick. Each of these bricks is worth anywhere from $500 to $1000, depending on the size. Twenty-four carat‡ gold is far too soft to use for fountain pen points, so it is necessary to alloy it somewhat, to make it harder and stiffer. The fine gold is melted

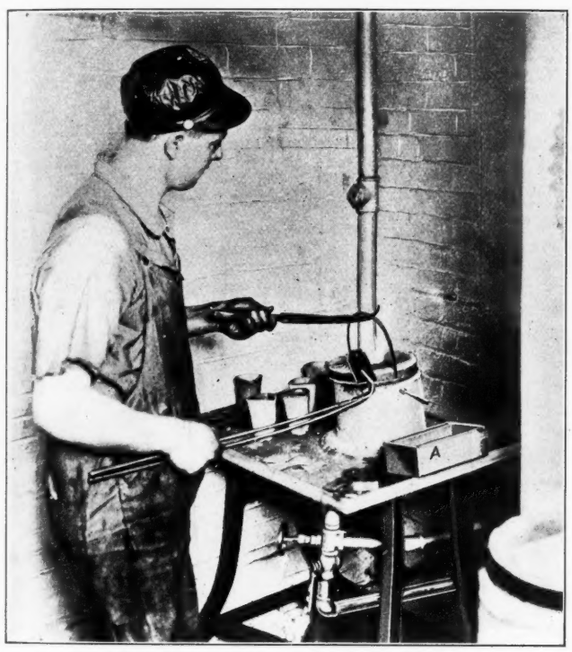



Fig. 1. Melting the Gold for the Pen Points

with the alloy in a crucible, as shown in Fig. 1. Here the proper proportions of gold, silver and copper are mixed in, the amounts being 233½ pennyweights of fine gold (24 carat), 92 pennyweights of fine silver and 76 pennyweights of fine copper. This, when cast, produces a block 10 inches long by 1 inch wide by ¼ inch thick, weighing 401½ pennyweights. The reason for making a block of this weight is that when it is rolled out to the proper thickness it makes a sheet which can be conveniently handled. This alloyed gold is 14 carat, which is the standard for fountain pen points.

Following the production of the block which is cast in the iron box *A*, Fig. 1, the block of gold is conveyed to the rolling department, where it is passed through steel rolls from fifteen to twenty times until it is rolled out into a sheet of the required thickness. Rolling hardens the gold somewhat, and if carried too far without annealing is likely to produce cracks; it is therefore necessary to wind up the rolled sheet, and put it in an annealing furnace, where it is heated to a dull red, after which it is taken out and allowed to cool off gradually. The sheet is annealed twice before it is rolled out to the required thickness—about 1/64 inch. The blanks for the pen points are again rolled out to the exact thickness, after the iridium has been fused onto them.

### Cutting the Blanks for Pen Points

After rolling the gold to the correct width and thickness, the strips are taken to the foot-presses, one of which is shown in Fig. 2. The blank is cut out by means of a blanking punch and die to approximately the required shape. After

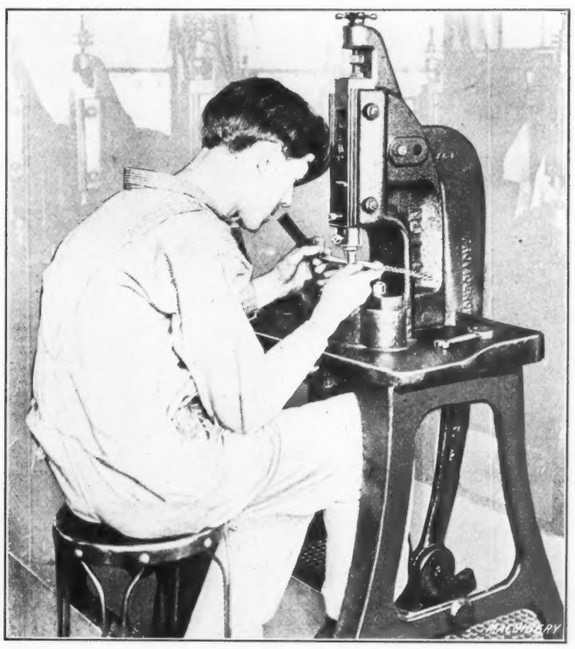


Fig. 2. Blanking the Gold Pen Points in a Foot Press

blanking, the pen point is taken to a miniature milling machine, where a narrow ledge is milled across the point, the object of which is to form a seat for the iridium to be fused on.

### The Discovery and Characteristics of Iridium

In 1803 Smithson Tennant found that the metallic residue which remains when platinum ores are dissolved contains two elements, to one of which he gave the name "iridium" on account of the varying color of its salts, and to the other "osmium," from the Greek, a smell, because of the peculiar odor which its volatile oxide possesses. Iridium is found

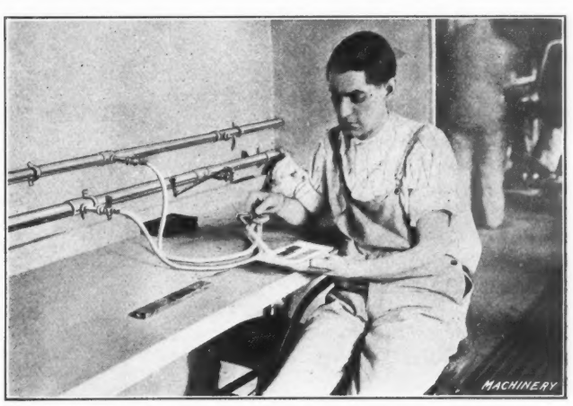


Fig. 3. Fusing the Iridium on the Gold Pen Points

in platinum ores in considerable quantities in the form of the alloys, platiniridium and osmiridium. The first of these occurs in grains and frequently in small cubes with rounded edges. Iridium is one of the hardest known metals and costs $1500 a pound. It is secured in the Ural Mountains on the border of Asiatic Russia.

The atomic weight of iridium, taking hydrogen as 1.008, is 191.5. The specific gravity is 22.4 and the point of fusion is between 1950 degrees C. (3542 degrees F.) and

* For a description of the methods used by L. E. Waterman Co., in the manufacture of the rubber pen parts, see the December number of MACHINERY.

† Associate Editor of MACHINERY.

‡ The word carat as applied to gold means the twenty-fourth part and is used to designate the proportion of pure gold. The gold used for commercial purposes is not pure, but generally contains a certain proportion of silver or copper. Pure or fine gold is called 24 carat, but when it contains ten parts of silver, copper or other metal, it is called "14 carat gold," because only fourteen parts of the whole is pure gold. The alloy used for Waterman's fountain pen points consists of 14 parts pure gold, 5.5 parts silver and 4.5 parts copper. This alloy is called 14 carat gold.

2200 degrees C. (3960 degrees F.). Iridium is very brittle when cold, but at white heat is somewhat malleable. The specific gravity of the fused metal is 22.15. The extraction of iridium is carried on in a manner somewhat similar to that used for other precious metals. The processes used in the extraction of the platinum alloys can be found in the majority of up-to-date books on chemistry. Iridium can be fused and volatilized in an electric furnace.

Gold pens have been found to resist the friction and wear incident to writing, as they glide over the paper better than pens made from any other metal. Gold is also used chiefly because of its non-corrosive and non-oxidizable qualities. Gold alone, however, is soft and will not last long. Before the adoption of iridium, the gold pen point was tipped with diamonds or rubies, which, of course, made the pen very costly. It was found, however, that iridium could be fused with the gold and a much stronger and more durable pen point produced.

### Tipping the Gold Pen Point and Re-Blanking

A granule of iridium, about 1/16 inch square or smaller, depending on the width of the point, is fused onto the gold pen. For stub pen points two granules are used, one on each nib. To accomplish this the operator dips a camel's hair brush in the fluxing fluid and applies this to the nibs. Then he takes a granule of iridium, holds it on the pen with a pair of tweezers and locates it by means of a magnifying glass in the correct position. The pen points with the

Fig. 4. General View of the Gold Pen Point Grinding Department

iridium granules on them are then placed on a charcoal block. The operator now, as shown in Fig. 3, fuses the gold around the iridium by means of a gas- and air-torch, thus retaining it in position. The reason for forming a seat on the pen for the iridium is that the pen can be ground down flush on its under surface and still have a layer of iridium to protect it and to increase its wearing qualities.

The blank up to this operation is considerably thicker than is necessary for the finished pen point, and to reduce the blank to about 0.008 inch thick, it is passed through a small pair of steel rolls. A horizontal slit is cut in the upper roll in which the granule of iridium fits, so that it will not be broken during the rolling operation. It is necessary to roll out the blank to give it sufficient resiliency, because the fusing on of the iridium granule anneals it. The shape of the pen point after rolling is distorted, it thus being necessary to blank it out again. This is done in the foot-press shown in Fig. 2.

After trimming, the heart-shaped hole *A*, Fig. 7, from which the slit forming the nibs extends, is cut in the pen point. Then the number and trademark are stamped in the pen point, in the screw press shown in Fig. 5, after which it is formed to the shape shown in Fig. 7 by a forming punch and die held in a screw press.

### Slitting the Pen Point

The next operation consists in slitting the pen point to form the nibs. This is accomplished in the manner shown in Fig. 6. The pen point is held in a pair of tweezers *A*, which are supplied with a rubber handle. The operator grips these tweezers in his right hand, allowing them to rest on the support *B*. The pen point *C* is then brought into contact with the rapidly revolving copper disk *D*, which is 3 inches in diameter by 0.0055 inch thick, and rotates at 4000 revolutions per minute. The disk is punched out from a copper sheet of the required thickness, and projects about 3/8 inch above the supporting washers *E*, which steady it while slitting the pen point.

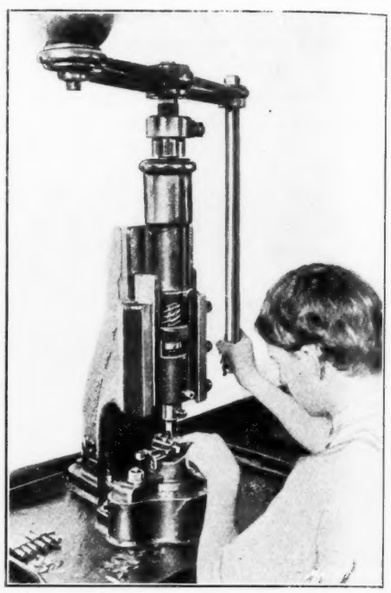


Fig. 5. Stamping the Name on the Gold Pen Point in a Screw Press

Of course this disk rotates at a high speed and it requires considerable pressure to deflect it. The pen point is held on the disk by the operator, so that the slit will come directly in the center of the heart-shaped hole.

The copper disk *D* is coated with superfine emery, mixed with oil which is applied to it by means of a piece of felt fastened to a stick. It is impossible to slit a gold pen point tipped with iridium in the same manner as a steel pen is slit, because the iridium, on account of its extreme brittleness, would fly into fragments, if a slitting punch and die were used. The emery-coated copper disk, however, works very effectively and cuts through the iridium so easily that it seems to require no special effort at all on the part of the operator.

The slitting of the pen point, however, requires considerable skill, as the slot between the nibs must be perfectly straight; that is, if the slot is on a slant, the nibs will interlock as shown at *B* in Fig. 7. This causes one nib alone to bear on the paper and prevents sufficient ink from reaching the point; in fact, the pen will hardly write at all. However, this can be rectified when grinding, as will be explained later.

### Grinding the Pen Point to the Desired Shape

The operations previous to grinding require considerable skill on the part of the operator, but the grinding of the

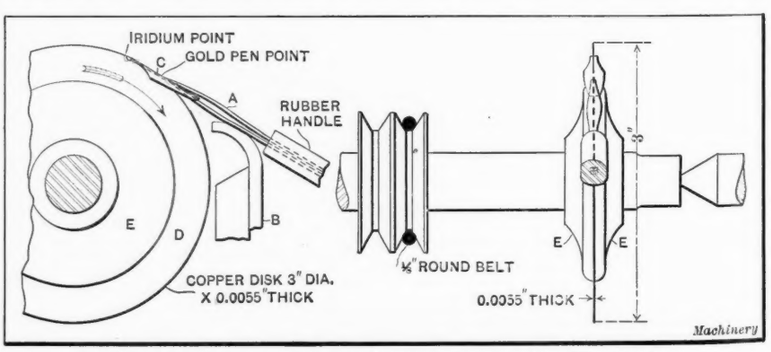



Fig. 6. Slitting the Gold Pen Point on an Emery-coated Copper Disk

pen point is really the most important one of all. In this operation the pen point is given its final shape. The operator holds the pen point *A* in a pair of tweezers, as shown in Fig. 8, and applies it to an emery-coated copper wheel *B*, which is provided with four different diameters, so that each part of the pen point can be ground to the required shape. This operation is so important and requires such skill that the shaping of the pen point cannot be watched by the naked

eye, but requires the aid of a powerful magnifying glass. The operator grinds a little, removes the dirt from the pen, and then looks at it with the magnifying glass shown at *C*.

The slit is also squared up in this operation, so that the nibs will pass by each other freely without interlocking. The disk shown on the left end of the spindle, which is 3 inches in diameter by 0.007 inch thick, is used to square up the slit. This disk is made from taggers iron* and is coated with superfine emery applied with a piece of felt. The shape of the slit is clearly shown at *C* in Fig. 7. As

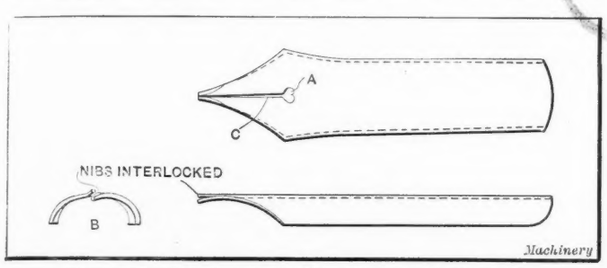



Fig. 7. View showing the Action of Improperly Slitted Nibs

will be noticed, it gradually increases in width from the point until it reaches the heart-shaped hole *A*.

A general view of the gold pen grinding department, in which the grinders are seen at work, is shown in Fig. 4. In this illustration can also be seen the washing troughs and the cans used in collecting the gold dust which adheres to the hair and hands of the grinders.

### Setting the Pen Point

Each shape or grade of pen point requires a different "set," so that it will feed the ink freely and evenly. A stub point —another name for a wide-pointed pen point—must have less resiliency than a fine point, so that the former will feed the ink much more freely than the latter. This "set" to the pen point is accomplished by hand. The setter grips the pen point between the first finger and thumb of both hands and moves the nibs back and forth past each other. Bending the nibs back and forth in this manner stiffens them and gives them greater resiliency.

The desired set is a matter of "feel" only. The setter, after moving the nibs back and forth, holds the nibs under a jeweler's magnifying glass, and slightly depresses the frame of the magnifying glass on the nibs, spreading them apart. The amount of pressure required to separate the nibs is all that the operator goes by in setting the pen point. It can therefore be seen that setting the pen point is a matter of experience only, and the setter must thoroughly understand the action of the nibs for the different grades of pen points. Besides setting the pen point, the setter also smooths it up on superfine emery cloth so that it will write freely without scratching, all sharp corners being removed. The setting and final touching up of the pen point is the last operation.

### Assembling the Pen Point—Feed and Point Section

To assemble the pen point and feed in the point section, the operator places the feed on the pen point, so that by looking down on the top of the latter the feed can just be seen projecting slightly in advance of the curved section of the pen point. The pen point and feed are then placed in the point section, and the latter is screwed into the barrel. The assembled pen is now held over a Bunsen burner to soften the rubber feed slightly. The feed is then pressed down on the pen point so that there will be no space at all between them. To see that the feed fits properly, the operator inspects it by means of a magnifying glass. If there should be a space between the under side of the pen point and the feed, the pen would overflow, which, no doubt, has been the experience of many a novice who has attempted to place a pen point in the point section.

The sectional view of the assembled pen, Fig. 9, shows the feed and pen point placed in their proper positions relative to the point section. This illustration also shows the twin rivet used in holding the clip-cap to the rubber cap. The ball is swaged onto the clip-cap instead of being soldered, as was the practice formerly followed.

### Collecting the Gold Dust

The gold dust which results from grinding and working 14-carat pen points is worth about $12 an ounce, and as over 1,500,000 pens are turned out per year, it is evident that the waste is considerable. The sweepings from the grinding-room floor alone are sold for $4500 a month, while over $500 worth of gold is reclaimed each month from the water in which the

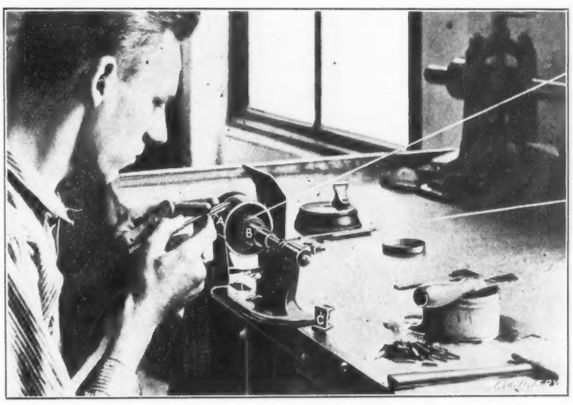



Fig. 8. Grinding the Gold Pen Point to the Desired Shape on Emery-coated Copper Wheels of Various Diameters

grinders wash their hands and faces. Every grinder is supplied with a new pair of overalls each "clean up," and the old ones, which are burned, return as much as $5 in gold dust—a case where use increases the value.

### Fountain Pen Ink

As the L. E. Waterman Co. makes its own fountain-pen ink, it may be of interest to give a short description of the materials used and the methods of manufacture employed. The ordinary writing fluid is, as a rule, not clean enough to give good results in a fountain pen as it clogs the feed, causing the ink to flow unevenly. Fountain-pen ink consists mainly of tannic acid, gallic acid and water. The tannic and gallic acids are obtained from a peculiarly shaped nut, called "nut-galls," which is deposited by an insect on the leaves of trees in Asia Minor. These nuts, when received at the factory, are crushed and put in a piculator, where water is poured on them. The fluid from the piculator is boiled to extract the acids, after which an aniline coloring matter and other chemicals are mixed in with the acids to produce the record inks, as well as the various colored inks.

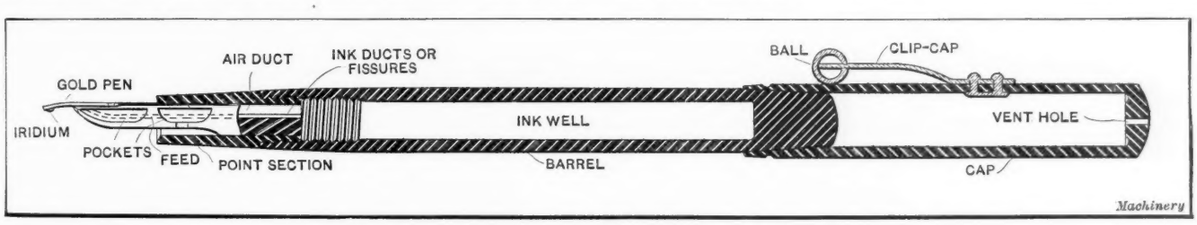



Fig. 9. Sectional View of L. E. Waterman's Ideal Fountain Pen

* * *

It is stated that a high-speed steel containing about 0.25 per cent of vanadium has a cutting capacity which is almost double that of steel containing no vanadium.

* Taggers iron is the name given a class of very thin sheet iron, about 0.007 inch thick, which is used largely for metal tags, and no doubt derives its name from its use. This grade of sheet iron has a slightly mottled appearance due to the oxide adhering to the surface. It is a special grade of Russian sheet iron produced by hammering a pile of heated sheets having slight projections or indentations on its surface.

## NORTON COMPANY'S MEDICAL PLANT*

In May, 1911, the Norton Co., of Worcester, Mass., established a medical department in its works. This department was the outcome of two ideas: first, that a medical department would increase the efficiency of the employes and, second, that it would also increase the already well-marked good feeling between the men and the company. To obtain maximum production, the human material must be of the best quality, and the best quality in factory employes means perfect physical health. The problem of health, therefore, must be taken into consideration, if increased efficiency is desired, and we might say that if every man employed were physically well, all departments would run with the utmost smoothness.

The medical department adopted the following procedure to investigate the condition of the employes: 1, a complete physical examination of all employes; 2, immediate attention to all defects found on examination and an effort to rectify them; 3, re-examination of employes having physical defects to see that they are in the best possible condition; 4, immediate attention to all employes incapacitated by injury or illness and an effort to get them into normal condition in the shortest time. The fulfilling of these conditions in a systematic manner would mean that all those unfit for work would be immediately eliminated, the capacity of those partially unfit would be increased, sickness would be prevented, wounds and injuries would be properly treated, poisoning would be avoided, and tuberculosis and other contagious and dangerous diseases would be eliminated.

A hospital consisting of a room of moderate size, well-lighted and ventilated, is equipped with the necessary outfit, such as a glass-topped table for dressing, sterilizer for instruments, dressings, examining table, bowls, instruments, etc. A doctor is regularly in charge, giving about three hours a day at the factory, about one and one-half hour in the morning and the same length of time in the afternoon. In the morning he examines all sick employes applying for treatment, either prescribing for them, or, if they are sick enough to stop work, advising them to call in a physician. Those having minor ailments are treated in the hospital in the works.

The complete elimination of accidents in a large factory is practically impossible and in the majority of cases, if these accidents receive proper and careful attention, they prove merely an inconvenience to the employe, perhaps preventing him from working for forty-eight hours, but seldom longer. Even the smallest wound or scratch, if it becomes infected, may lead to a long and sometimes serious illness, so that proper attention and thorough cleansing of all wounds is of prime importance. It is also important that an employe receive immediate attention by someone in the department in which he is working in order not to break up the work of the other employes. To carry out this scheme the Norton Co. arranged to have all the foremen of the various departments take special instruction from the doctor once a week for ten weeks. They were given thirty-minute talks upon the various accidents most frequently met with and their immediate treatment. Each lecture was made as simple as possible and was illustrated by blackboard drawings and actual demonstrations, such as putting on bandages, splints, etc. At the end of this course of lectures, an examination was held and since then there have been examinations and conferences about once a month. The foremen have shown considerable interest in this part of their work and have ably demonstrated their ability to apply the principles they have learned. Each foreman is supplied with a "first-aid jar," containing bandages, sterilized gauze pads, finger splints, etc.

Upon entering the employ of this company, each employe receives a complete physical examination and any defects, such as abnormal conditions of the back or abdomen, are charted on a diagram. After examining a man, the doctor discusses his physical defects with him and strongly urges him to attend to any physical weaknesses which he may have. Those men having ruptures are advised to wear trusses, those with poor teeth are advised to go to a dentist, and all are instructed in the care of minor diseases. If the employe examined is too sick to work he is sent at once to his family physician. When an employe is found to have a weak heart and is doing work not suitable to his condition, his work is modified in accordance. Men having organic diseases are required to report at varying intervals of time for examination and advice.

In connection with the dispensary the foremen are provided with "Sick Slips" which they fill out in all cases of injury or sickness, giving the date of absence from the factory and the number of days or hours of time lost. These are filed by the doctor in the order of the department numbers, and the length of absence and cause are noted on the original examination card. When a man has left the factory without seeing the doctor, he is sent for on his return and the cause of his absence ascertained. All physical examinations are filed by name and two lists are kept, one of normal men and the other of those having defects. By this system the exact condition of each employe is known, as well as any accident or sickness he may have had and the length of time he has lost by it.

This work has been going on for six months and the development has naturally been slow. It will be several years before statistics can be obtained to show whether or not efficiency has been promoted. However, judging from the data now on hand, there is good reason to believe that ultimately a high degree of efficiency will be achieved.

* Abstract from *Grits and Grinds*, November, 1911.

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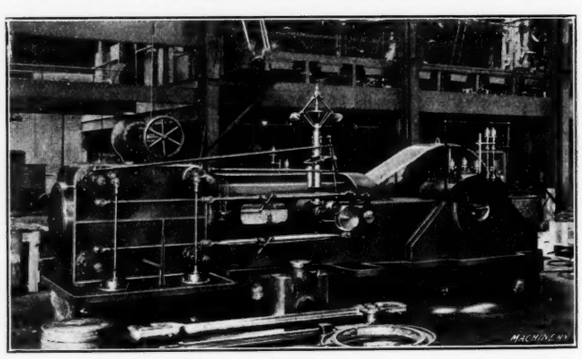
## A 32- BY 48-INCH CORLISS ENGINE BUILT IN SIXTEEN DAYS

When the Mesta Machine Co., Pittsburg, Pa., established the record, a short time ago, of building a heavy Corliss mill engine and mill for the Sellers Mfg. Co., of Chicago, in exactly twenty-six days, it was thought that the limit of speed had been reached on this class of heavy machinery building. However, this record has again been broken by the Mesta Machine Co. in building a 32- by 48-inch Corliss engine (shown in the accompanying engraving) for the American Sheet & Tin Plate Co.'s plant at Martin's Ferry, Ohio, to replace an old engine that had broken down beyond all repair. The order was placed with the Mesta Machine Co. on account of its reputation for record-breaking engine building, and shipment was



Thirty-two by Forty-eight-inch Corliss Engine Completed in Sixteen Days

promised in three weeks' time. Sixteen days after the order was received, the complete shipment was made, and fourteen days later the engine was put into operation, making a total of thirty days from the date the engine was ordered until the new engine was driving the mill.

All the parts of the engine had to be made from the raw material, including the forgings which were forged in the company's own forge department on a large steam hydraulic forging press, recently installed. Before the Mesta plant was equipped with steam hydraulic forging presses it required all of sixteen days to have a set of forgings delivered to the shop, and only a few years ago it required more than that time to make a casting of a Corliss cylinder of this size—this work alone taking more time than it now does to make the complete engine.

To make a delivery in such a short time requires a foundry equipped with molding machines and the most modern appliances for doing the work, as well as a completely equipped brass foundry, steel foundry and forge shop, and a machine shop equipped with all the tools and appliances necessary for modern engine building.

# APPLICATION OF AUTOMATIC FEEDS TO POWER PRESSES*

The demand for power presses for producing articles made from sheet metal has caused many devices for automatically feeding the strips or blanks to be attached to the various styles of presses. The types of automatic feeds most generally known are the single and double roll, grip, gravity, push, dial and reciprocating feeds. There are numerous ways of applying these types of feeds to power presses in order to adapt them to the specific requirements. Frequently feeds of two types, as illustrated in Fig. 5, are combined to facilitate production. The feeding devices illustrated in the following article are applied to the power punching presses built by the E. W. Bliss Co., Brooklyn, N. Y.

In addition to the economy of a more rapid production, the application of automatic feeds to power presses assists in protecting the hands of the operator, because the blank or stock is automatically fed to the dies, giving the operator no occasion to put his hands near the dies. Various kinds of feeds are applied to presses of every type, the kind of feed used depending upon the material to be handled. To entirely cover this subject would require an exhaustive article, so we will confine ourselves to a brief description of a few of the standard types of feeds.

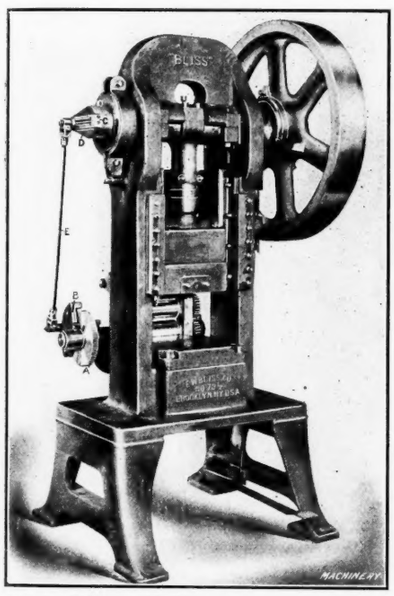


Fig. 1. Straight-sided Bliss Press equipped with a Single-roll Ratchet Feed

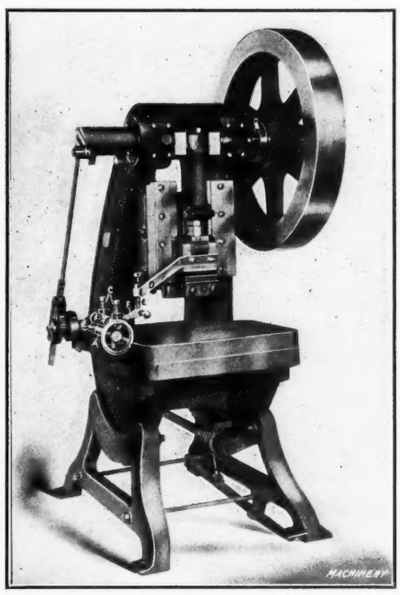


Fig. 2. Bliss Inclined Press furnished with a Rack-operated Roll Feed

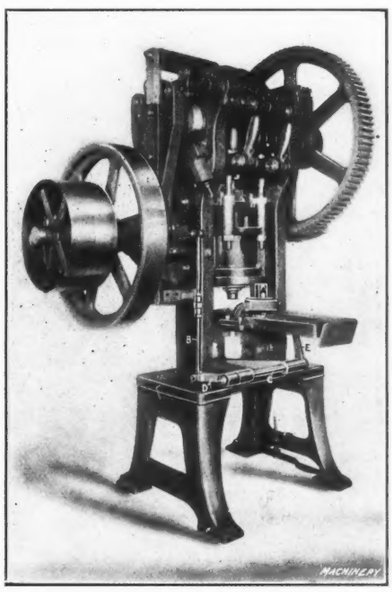


Fig. 3. Toggle Drawing Press having a Push Feed and Magazine

### Single-roll Feed

In Fig. 1 is illustrated a single-roll feed, fitted, in this case, to a straight-sided press. This type of feed is used for feeding strip stock, but the particular feeding device illustrated is not built in the regular manner, as the work for which it is used requires a very accurate feed—more accurate than could be obtained with the regular size of standard single-pawl feed. The difference in construction from the regular feed is in the ratchet *A*, which is operated by three pawls held to a segment disk *B*. This feature reduces the inaccuracy in feeding to a minimum without the use of a ratchet three times the circumference of the single pawl ratchet, which would be necessary to accomplish the same result with the old type of feed.

The type of ratchet feed illustrated in Fig. 1 can be adjusted for a wide range of length of feeds, the adjustment being made by means of an adjusting screw in the block *C*, held in the eccentric arm on the end of the crankshaft. Power is transmitted from the eccentric arm *D* to the roll shafts through the ratchet *A* and pawls, the connecting-rod *E* being fitted with universal joints. The roll shafts are connected by gears, as shown, and to avoid over-feeding, due to the momentum of the feeding parts, the lower roller shaft is fitted with a brake. The feeding device in this case is situated at the rear of the press, but it can also be arranged either in front or to the right- or left-hand sides, as desired.

Another type of single-roll feed, fitted to an inclinable press, is shown in Fig. 2. This feed differs from the one shown in Fig. 1 in the method of driving, the rack type of drive being used instead of the ratchet type. The rack type of drive is largely used for long feeding, as it gives a wider range of feed, with the same size rolls, than can be obtained with the ratchet feed. It is not advisable to feed over 90 degrees, or one-quarter turn of the rolls, with a ratchet feed, but with the rack feed several revolutions of the feed rolls can be made for one stroke of the press. This permits the use of small feed rolls, making a smaller and more compact attachment. The feed rolls shown in Figs. 1 and 2 are provided with an automatic release, this being more clearly shown in Fig. 2. This automatic release of the rolls is necessary when pilots are used in the punches. The operation of the automatic roll release is as follows:

Referring to Fig. 2, the feed rolls *A* and *B* are held in contact by means of springs *C*. The lower bearing in which the roll *A* is held, is stationary, while the upper bearing carrying roll *B* is movable. The releasing device consists mainly of a bar *D*, attached to the ram of the press, in one end of which is a set-screw *E*. The point of this set-screw bears on an arm *F* which is cast integral with the top roll bracket. As the ram of the press descends, the screw *E* comes in contact with the arm *F*, releasing the stock when the pilots in the punches enter the die. It will be noticed that the roll release arm *F* is provided with a handle so that the upper roll can be released by hand when starting a new strip.

### Push Feed

The toggle drawing press shown in Fig. 3 is provided with a push feed, the operation of which is simple. The flat blanks (which have previously been cut out) are placed in the magazine *A* from which they are removed one at a time to the dies, the feeding being accomplished by a traversing slide receiving its motion through rods *B* and *C*, and levers *D* and *E*.

### Friction Dial and Push Feeds

In Fig. 4 is shown an inclinable power press to which is fitted an automatic friction dial and also a push feed. This press is used for reducing and stamping shells which have been previously cut out and drawn in another press. In operation, the shells are placed on the table *A* from which they are removed to the revolving dial *B*, the top of which is flush with the table. The dial *B* carries the blanks to an automatic stop from which they are released one at a time by the cam and spring-actuated feed arm *C*, carrying them to the dies. The arm *C*, which is pivoted to the bracket *D*, is actuated by a cam *E* on the vertical shaft *F*. This shaft derives its power

* For additional information on automatic feeds for power presses and kindred subjects, see MACHINERY, October, 1911, "Automatic Feeds for Power Punching Presses," and other articles there referred to.

through the bevel gears shown, one of which is attached to the end of the crankshaft. From the vertical shaft *F*, power is also obtained to drive the revolving dial *B* through pulleys *G* and *H*, by a round belt running over suitably placed idlers.

Another feature of this press which might well be mentioned, but which in a measure could not be considered a feed, is the method used in removing the finished blanks. This is accomplished by means of a continuous operating endless belt fitted between the sides of the press and driven by a belt running over the hub of the flywheel. After the first blank has been fed to the dies and operated upon, the blank following it is carried to the die by means of the feed arm which pushes the first blank off the die onto the conveyor, the latter depositing the blank in a suitable receptacle.

### Friction Dial and Reciprocating Feed

A combination automatic friction dial and reciprocating feed fitted to an inclined press is shown in Fig. 5. Three operations are performed by this press simultaneously. Presses fitted with this combination of feeds are particularly adapted for the production of pieces on which there is a series of operations. The shell to be operated upon in this press is previously cut out and drawn in another press fitted with a feed similar to that illustrated in Fig. 4. After the shells have been blanked and drawn they are placed on the continuously revolving dial *A* which carries them up to an automatic stop from which they are released one at a time. Here they are gripped by the traveling jaws of the reciprocating feed which automatically carry them to each of the three dies *B*, *C* and *D* in consecutive order, finally discharging the finished product at the other end of the press.

The revolving dial *A* is driven by a round belt from a grooved pulley on the flywheel shaft. This belt is changed

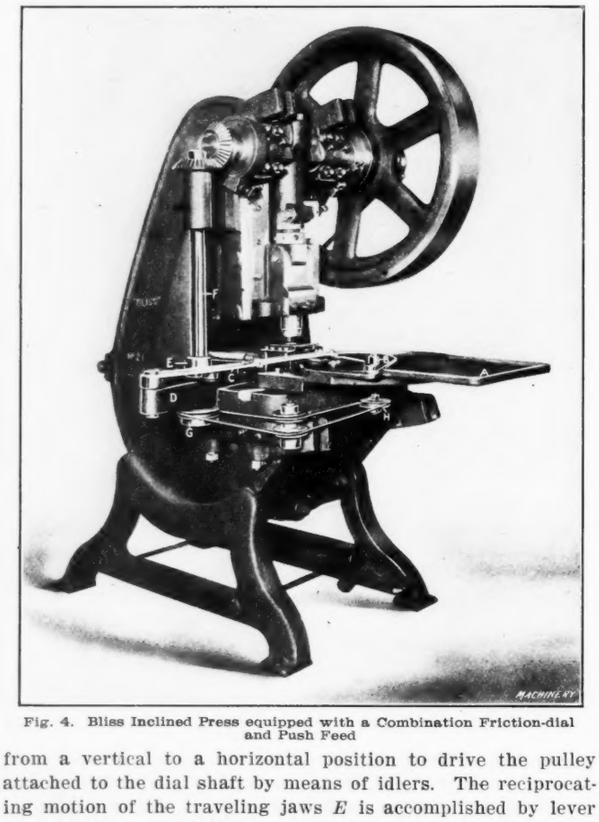


Fig. 4. Bliss Inclined Press equipped with a Combination Friction-dial and Push Feed

from a vertical to a horizontal position to drive the pulley attached to the dial shaft by means of idlers. The reciprocating motion of the traveling jaws *E* is accomplished by lever *F*, which is actuated by the "race cam" *G* on the end of the crankshaft. The automatic opening and closing of the jaws *E* is accomplished by motion transmitted from cam *H* through bellcrank *I*, link *J*, rod *K*, link *L* and levers *M* and *N*. By means of the handle *O*, the traveling jaws *E* may be independently opened at any position. After the first three revolutions of the crankshaft, the press performs three operations at every stroke.

Another type of feed which is so well known that it needs no description is the ratchet dial feed. It might be well to mention, however, that presses equipped with this feed are generally provided with a safety device. This device is so connected with the clutch used in stopping and starting the machine as to stop the ram on its downward stroke before it can do any harm, if it should so happen that the dial is prevented from assuming its correct relative position. It will be seen from the foregoing that the various ways in which feeds may be employed are practically unlimited, each and every condition requiring its own solution, whether a combination or single feed is used. The illustrations given, however, show means of eliminating danger to the operator and increasing the production.

* * *

## BROWNING STEEL GUN BARRELS

The following is the standard formula used by the United States Government for browning gun barrels and similar steel articles: Alcohol 1½ ounce, tincture of iron 1½ ounce, corrosive sublimate 1½ ounce, sweet spirits of niter 1½

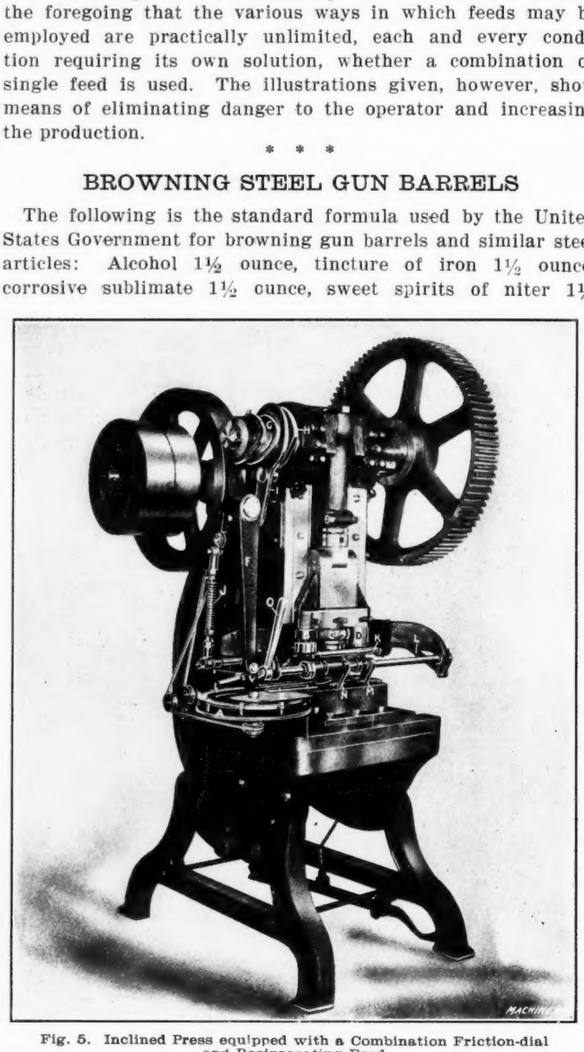


Fig. 5. Inclined Press equipped with a Combination Friction-dial and Reciprocating Feed

ounce, blue vitriol 1 ounce, nitric acid ¾ ounce, and warm water 1 quart. Dissolve the above ingredients in the water and keep in a glass bottle.

The gun barrel to be treated is cleaned with potash of soda to remove the grease, and all stains are then removed with fine emery cloth, so that an even bright surface is produced. The bore and vent of the barrel are closed by plugs of wood. The solution is then applied to the surface of the steel with a sponge and allowed to dry in the air for 24 hours, after which the loose rust is rubbed off with a steel scratch brush. Another coating of the solution is now applied, and allowed to dry in the same manner, after which the scale is again rubbed off with a scratch brush. Finally the barrel is washed in boiling water, dried rapidly and wiped with boiled linseed oil or given a coat of shellac.

* * *

At the last meeting of the German Machine Tool Builders' Association, it was stated that the volume of trade in machine tools during the last year had been satisfactory, on the whole, throughout Germany, but prices had not been so satisfactory, There has been an upward tendency in the cost of raw materials, and an increase in wages. German manufacturers are advised by the association to specialize along certain lines of machine tools. It is reported that the present outlook is satisfactory, and it is anticipated that the trade will be good for a considerable time.

## REMARKS BY THE ONLOOKER

Just at this time of the year MACHINERY's article in the December number on toy-making is happy and interesting. In everyday affairs many things come before our notice to which we give little thought as regards their means of production. It is the cheapness of mechanical toys that attracts the attention of the engineer and designer, and it is interesting to find out some of the reasons for their cheapness. Of course large quantities make for a low cost, but when you inspect a toy carefully you see at once that one of the fundamentals in commercial machinery is entirely neglected, that is, lasting quality. The article gives some surprising figures on the amount of money paid for toys; certainly it is a sum that most of us would hardly think possible. It is evident that very great ingenuity is shown in toy design and no small amount of real engineering skill in production.

The article on collapsible tubes brings to my mind the fact that they are produced in Germany, imported to America, paying a 35 per cent duty, and yet sold 10 per cent lower than American prices. I have this information from one of the largest tube users in America. As far as my informant knew, the quality of the American tubes is no better than that of the imported German tubes. One who has never seen the operation of making these tubes could hardly believe that the methods described so clearly, especially that of "punching" as it may be termed, could be satisfactorily carried on. The business of making tubes in New London is growing rapidly, and a great many of the special machines have been designed and built by Mr. Sheffield, which goes to prove that he belongs to a "mechanical tribe." After all, the soil of New England seems very much better adapted to the growing of collapsible tubes, sewing machines, scissors, machine tools, etc., than agricultural products.

The question of large quantities referred to is a great factor in mechanical production, as is clearly shown in the pages of MACHINERY by many articles which we call small tools in the shops. Take, for instance, the exhibit of drop-forged wrenches. A drop-forged wrench, beautifully finished, right up to size, and admirably proportioned, can be bought for, say, one-tenth the cost of producing the same wrench in a machine shop with ordinary appliances. This business of manufacturing drop-forged wrenches has been so highly developed that no one thinks now of attempting to make wrenches for himself, but simply orders one as he would a loaf of bread.

One of the interesting exhibits of drop-forging is that of the Billings & Spencer Co.'s multi-point diamond lathe tool. This tool strikes me as being one of the most ingenious labor-saving devices I have seen, but I don't quite see how all the points can be used unless the blank in the middle is made considerably longer than it appears to be in the illustration.

The introduction of high-speed tool steel has brought tool-holders into great prominence. It has always worried me in the past to see eighty cents on a dollar's worth of tool steel "loafing," while a few cents worth at the end of the shop was doing all the work. These tool-holders again show the ingenuity of the American mechanic, and I sometimes wonder whether anybody can get up a new form possessing any material advantages over those now in use. I hardly think that more are needed.

In looking at the advertisement of a hacksaw made in New Haven, Conn., my thoughts went back to the time when a Stubbs' hacksaw was the only one on the market so far as I knew. I have actually seen a man filing the teeth of one of these hacksaws, an operation which I think has not been performed in the United States for many years. The cheapness of modern hacksaws is a source of wonder; they may be regarded as another case of Yankee ingenuity.

When I saw the first "Lo-swing" lathe, it seemed to me that accurate production could not be expected from it, but upon buying one and using it, I found the principal difficulty was to clear away the chips. Having a certain number of shafts to finish to three diameters, I used the "Lo-swing" lathe on stock 2¼ inches in diameter. The first day I had to send out and buy a wheelbarrow of exceptionally large size to wheel away the chips, and I believe I lost my reputation as a man of veracity when I showed a visitor the piled-up chips of a few days' work. I know he said afterwards that I must have a large interest in the company building the lathe if I was ready to fake up what it could do, as I did. Of course the capacity of this machine is confined to moderate diameters—about 4 inches—but its design is in line with that of coming machine tools, having a limited range of capacity and capable of an enormous output.

Referring to the editorial "Efficiency in Men and Machines," I wish to say that while I agree thoroughly with the idea that a good tool should be operated by a good man, I think, Mr. Editor, that you overlooked the fact that a first-class machinist will not run a special tool for any great length of time. The work becomes monotonous to him and he thinks it is beneath his dignity. A man of low mental ability can be trained to run repetition machines, and run them satisfactorily. Such men produce a large output which enables the manufacturer to pay good wages, and it is to his advantage to do so.

I drew the attention of an acquaintance to the article by Mr. Lucas, "Making Dies for Hammering Machines," which gave him the first idea of the wonderful productive capacity of this type of machine for certain classes of work. Within twenty-four hours, he told me that he thought a business in which he was interested and which was paying almost no profit could be made profitable by employing hammering machines to form certain parts. So much for the value of a good technical article! The first machine for work of this character that I recollect was Mr. Goodyear's swaging machine—another Yankee invention.

The German decision concerning trade secrets is interesting, and it seems to me that the higher courts were right in deciding that the knowledge which a man acquires in the course of his work can be used freely by him even if it be in competition. It could hardly be expected that a beautiful melody once heard by a musician could be forgotten by him, and how can a man forget experience which he has gained in years of work? How can we deny to him his right to use his knowledge afterwards?

In reading the description of the manufacture of fountain pens I was astonished to learn that there was so much hand work required. I naturally thought that the enormous number produced would have resulted in the development of more automatic machinery.

Referring to the articles on "The Manufacture of the Ross Rifle," we are all talking now of peace, and most of us believe in peace when we have gotten too old to do any more fighting. But how much the mechanical world owes to military demands! Hall began the production of interchangeable parts of guns in Maine years and years ago, and I think it is fair to say that had this system not been called into existence by military demands, cheap cutlery, sewing machines and a thousand and one other articles now within the reach of all, would not have materialized nearly as soon as they did. In passing remarks on the gun manufacture, the ingenuity in making the fermetures of guns is remarkable. It seems a very simple problem to close a hole and open it again, but I estimate that at least 1500 patents have been issued on breech closing devices, and the end is not yet. The problem becomes more and more complicated with the increase of breech pressures that has to be provided for. Simplicity is absolutely necessary too.

The concrete information given in MACHINERY concerning gear cutting has lifted a great load from the shoulders of designers. The article by Mr. Burley giving data for the depth and width of land of end-mills having various numbers of teeth is an example. But we are all specialists today, and it is a great deal easier to write to a milling cutter manufacturer, telling him what we want, and let him run the risk connected with making and hardening a cutter than it is for us to try to do such work in the ordinary shop.

In the article on "Methods in Automobile Manufacture," by Mr. Hays, Fig. 6 shows connecting-rods being milled. It seems rather strange when considering this operation that three rods are practically standing idle awaiting their turn to be milled while one is going through the operation of being finished. Is not time lost here? Would it not be much better

and cheaper to use a simple single operating machine and mill the rods in multiples? Such a machine could be designed and built at a small cost, and one man could attend to the work and be doing something all the time instead of standing by, looking on and watching the parts take their turn being machined. This is a crank notion of mine, but I find that it is "taking hold," as the boys say. I am now designing a machine that will cost less than $200, and will replace machines that cost over $4000, and my machine will have the great advantage of not being able to do anything wrong. It will have the disadvantage, however, that it can be used for only one operation, thus making it so special that in case the work is given up the machine's value is only what it will bring for junk.

In speaking of small tools which can be obtained today, twist drills seem to give the largest return for the money of anything that goes into the machine shop. They last a long time if properly used, but judgment is required of the user. In a large shop, not very far from New York, I saw a barrel full of drills over 2 inches diameter, every one of which was split on the end. I had never had this happen in my own experience, and upon investigation found that the trouble came from running the drills too slow with too heavy a feed. My way of using drills above 2 inches diameter, or even 1½ inch diameter, is always to drill a pilot hole, say ¼ inch diameter. I think most mechanical men will agree with me that the pilot hole saves time and drills.

Almost every machinist is likely to believe, if he is of the old-time sort, that he ought to harden his own tools, and in fact a good many think that unless they grind their own tools they won't get good results, but it has always seemed absurd to me that a man who only occasionally hardens a tool and draws its temper could expect to even approach the quality of work turned out by the man who is doing it constantly. We have a concern in South Boston that can harden almost any tool or caseharden and anneal almost anything. I have seen some of the work produced by the New England Annealing Co., and it simply makes the hardening and tempering work done in the ordinary shop look foolish.

I want to say one thing more about twist drills, and that is, it would be a great convenience to users if the size were stamped in more than one place. The size is often obliterated by misuse, of course, and time is lost in calipering drills. I know one shop that has a good method which helps out considerably. All drills in the sixty-fourth sizes have a nick ground in the taper shank. This nick enables a man to take a sixty-fourth-inch size even in the dark, and has often prevented the making of serious mistakes. W. D. F.

* * *

A boat operated by wireless transmission of electricity was recently exhibited on the Danube at Vienna. The boat carries a storage battery which furnishes the motive power. The new invention consists in controlling this motive power, the steering gear and other mechanisms, by electric waves from the shore. At the exhibition the boat moved forward and backward, turned to the right and left, described various curves, was guided to definite points, rung bells, exhibited flags and lights, etc., giving proof of effective control. The mechanism, however, was far from perfect in that the response to the operator's will was hesitating and inexact, and the range limited to some few hundred feet. The exhibition, however, notes the beginning of a development which possibly will have some importance.

* * *

According to a report made by the House Committee on Expenditures in the Post Office Department, the 10,000 publishers in this country reported an output of more than 6,500,000,000 copies, weighing 1,750,000,000 pounds during the past fiscal year. Of this the postal service handled 951,001,669 pounds, for which it received 1 cent per pound, excluding 500,000 pounds which were carried free within counties; 840,466,574 pounds were delivered by the publishers, newsboys, news companies, etc., 202,729,510 pounds were delivered by express and 121,491,748 pounds by other rail shipments. The rate by express and rail varied from ¼ to 1 cent per pound. The bulk of the shipments, however, was sent at the rate of ¼ to ½ cent per pound.

## ON THE CHOICE OF A PROFESSION

The following correspondence regarding the question that every ambitious young man must decide for himself is submitted without comment except that the answer to us seems particularly apt and expressive.—EDITOR.

April 2nd, 1910.

The Cutler-Hammer Mfg. Co.
Milwaukee, Wis.

Gentlemen: I write for a little information. I am going to study either electrical or civil engineering in an university next fall, but I have not decided which to study. Could you tell me what kind of work is to be done along these lines, and what salaries are paid? Or could you tell me where to get some reliable information on the subject?

Yours respectfully,

---

Dear Sir:—We are in receipt of your letter of April 2nd stating that you intend to take up next fall the study of either electrical engineering or civil engineering, but are undecided as to which of the two professions it would be better to adopt. We would gladly comply with your request for advice if this were a matter in which the advice of one person would be helpful to another, but the question is one of those that every man must determine for himself. If instead of entering a university you contemplated marriage and had written us, "I intend to get married next fall; which shall I marry, a blonde or a brunette?" you can realize that the question would have been a difficult one for us to answer, but no more so than the question you have propounded in your letter. If you are in love with electrical engineering, be an electrical engineer. If you are in love with civil engineering, be a civil engineer. And, if you are not in love with either of them but merely think that it would be nice to be an engineer of some kind follow the advice of *Punch* to people about to marry—"DON'T."

It really makes no difference what profession you adopt or what business career you decide to follow so long as you do well the thing that you undertake to do. Carlyle said "No man is born into this world whose work is not born with him." and sooner or later all of us find the work we are best fitted to do.

As to the question: "What salaries are paid," we are equally unable to reply to this, and we do not believe that anyone who thinks first of his salary and then of his work is ever likely to accomplish much in any profession or industry. The things that are really worth while doing are done by the men who work for work's sake, for the love of doing, and for the satisfaction that comes to every man when he has done a thing well. The salary follows the work, as trade is said to follow the flag, and you may be sure that, whatever work you do (if it is work that is worth doing and is done well) you will nearly always receive in dollars and cents the value of your labor. Not quite the full value, perhaps, for the man you work for is entitled to a profit on you as on everything else in which risk of capital is involved.

For information regarding courses in electrical and civil engineering, we suggest that you write to the Ohio State University, Columbus, Ohio, and with best wishes for your success in whatever career you may elect to follow, we are,

Very truly yours,
THE CUTLER-HAMMER MFG. CO.
Chas. L. Benjamin,
Advertising Manager.

* * *

A typical form of railway water tank is that having the tank mounted on a framework of steel or wood. A new form has been adopted on the Cotton Belt Ry. at East Waco, Texas, where a tank 24 feet in diameter and 35 feet high has been erected. This tank is mounted on a low concrete foundation and is provided with the usual gage and delivery spout. The space below the discharge pipe acts as a settling chamber and affords a reserve capacity that can be drawn on in emergencies, when the normal water supply fails. Another point in favor of this construction is less cost and greater durability than the common form. The water and lower shell courses act as the support for the tank proper, that is the portion above the discharge pipe. This form of water tank is symmetrical, easy to keep painted, and simple to erect.

# LETTERS ON PRACTICAL SUBJECTS

**We pay only for articles published exclusively in MACHINERY.**

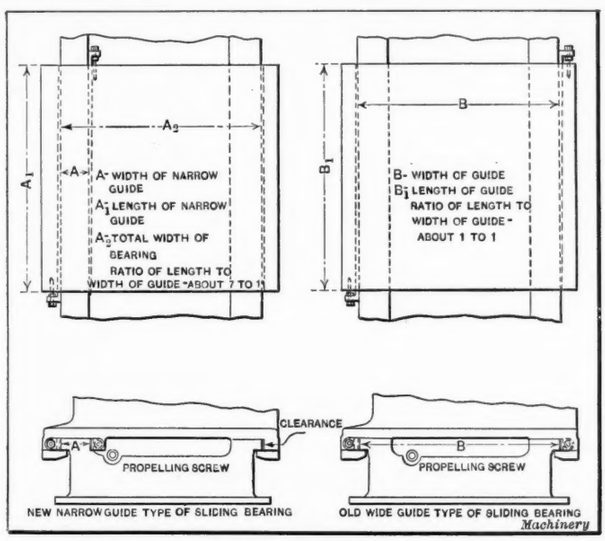
## THE INTRODUCTION OF THE NARROW GUIDE ON MACHINE TOOLS

In compliance with your request for a statement from me as to the reason for introducing the narrow guide on our tools, the following will give you our experience:

About the year 1897, we required a horizontal drilling and boring machine, and not finding one on the market to suit our purposes, we concluded to build one that would fill our requirements. This we did on the general lines then in practice by other builders.

In testing the machine out, we soon discovered that the alignment of the spindle in being moved to different locations, transversely by the movement of the column on its runway, and vertically by the movement of the saddle on the column, was inaccurate, which we discovered was caused by the necessary looseness of the sliding fits of the column on the runway, and of the saddle on the column. The wide surfaces then in use by the builders of these tools, whose designs we followed, were provided with guides at the outer edges of these surfaces only.

The looseness necessary to permit the slides to move freely was always sufficient to change the alignment of the spindle when the location of the saddle or column was changed, and was sufficient to make the cutting head (when used for milling) drag at its back edge into the milled surface. Seeing this difficulty, we realized at once that we could reduce this inaccuracy of the alignment of the spindle to a minimum, by making the guideways as narrow as practicable, and as much greater in length than the width as the character of the machine would allow. This we have done since on all of our tools with marked success, except our planers, on which the necessity for this narrow guide does not exist to the extent that it does on horizontal boring machines and tools of that character.


A- WIDTH OF NARROW GUIDE
A1 LENGTH OF NARROW GUIDE
A2 TOTAL WIDTH OF BEARING
RATIO OF LENGTH TO WIDTH OF GUIDE - ABOUT 7 TO 1
B- WIDTH OF GUIDE
B1 LENGTH OF GUIDE
RATIO OF LENGTH TO WIDTH OF GUIDE - ABOUT 1 TO 1
CLEARANCE
PROPELLING SCREW
PROPELLING SCREW
NEW NARROW GUIDE TYPE OF SLIDING BEARING
OLD WIDE GUIDE TYPE OF SLIDING BEARING
Machinery

The Narrow Guide Type of Sliding Bearing, and the Wide Type

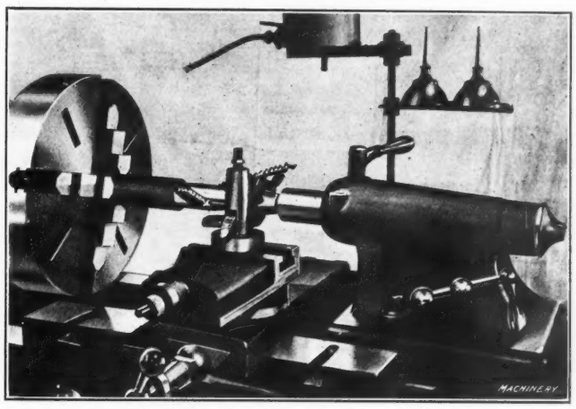
When the attention of Professor Sweet of the Straight Line Engine Co., was called to this feature in our tool he recognized at once this improvement and gave us an order for a tool embodying it. The late Mr. E. P. Bullard, of the Bullard Machine Tool Co., happened in our shop soon after we had adopted this narrow guide, to see how the vertical mills were going that we had purchased from him a short time before, and he thought so well of it, that he proceeded to use it on the cross-rails of his vertical mills, and we notice that other builders of tools have adopted it also. At this time, we also showed Mr. Bullard a device we had applied to his vertical mills, for stopping the table, and later on, he supplied a device on his mills for this purpose. There is no question as to the narrow guide being an improved method of guiding the tool-carrying head of any machine, and I predict its more extended use in the future.

J. S. DETRICK
Pres. Detrick & Harvey Machine Co.

Baltimore, Md.

## DRILLING BY POWER FEED

When drilling a large hole in a solid piece, such as an iron casting, a bar of steel, etc., it is a tedious job to feed the drill in by hand, especially when the hole is very deep. Having had considerable drilling of this kind to do, the writer struck on the following plan: The drill, which has a tapered shank, is forced into the sleeve of the tailstock, and the tailstock head is clamped to the lathe bed. A dog is then fastened to the drill as illustrated, the tail resting on the toolpost base. The tool is clamped in the toolpost, as shown, bearing against the rear of the dog, and the nut and handle are removed from the screw in the back of the tailstock spindle, thus allowing the spindle to move freely out of the tailstock. The attachment is then ready for operation when the feed-nut is engaged with the lead-screw, thus traversing the carriage; and as the dog is backed up with the tool in the toolpost, the drill is fed into the work.

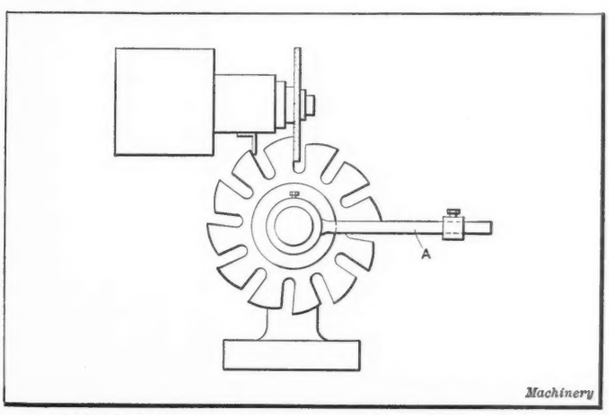



Drilling a Large Hole by Power Feed

C. E. POND

## SHARPENING A HOB IN A SHAPER

In the October number of MACHINERY, Mr. E. J. Carlson describes a method of sharpening a hob in a shaper. Apparently the hob in question had straight flutes, otherwise the method indicated would not have been satisfactory. If the flutes are spiral (or, more strictly, helical) it will be necessary to turn the hob arbor through an angle in the horizontal plane equal to the pitch or spiral angle of the flutes, and to attach a guide-finger to the head carrying the grinding wheel instead of mounting an indexing bracket on the table of the machine. The guide should be placed on the grinding head so that its point is immediately beneath the axis of the




Method of Sharpening Hobs having Spiral Flutes, in a Shaper

grinding wheel arbor and a tooth ahead of the wheel, as shown in the accompanying illustration.

As the guide-finger moves with the wheel in a straight line, it causes the hob to turn slightly about on its axis; the combination of these two movements results in the formation of the spiral or helical cutting edges of the hob. To keep the teeth against the guide-finger (which should be wider than the spaces between the threads on the hob, so as to provide continuous action between the finger and the hob), either a slight pressure of the hand has to be applied or a small suspended weight has to be attached to the end of a cord or string wrapped once or twice around the hob arbor.

Another way of doing this is to fasten an adjustably weighted arm on the hob arbor, as indicated at *A*. This method, it should be noted, can only be applied to hobs having equally spaced flutes; where the flutes are unevenly spaced, the guide-finger would have to be placed so that its point falls immediately beneath the grinding wheel, and touches the bottom of the flutes in the hob. This condition is much more difficult to effect than the previous one, because the guide-finger has to be made much smaller and consequently weaker, thereby increasing the risk of something going wrong.

Sheffield, England. GEORGE W. BURLEY

## SPEED-REDUCING MECHANISMS

In the October number of MACHINERY an article appeared on speed-reducing mechanisms, written by Mr. S. Hurley. A statement is made which, although correct in substance, in this instance is wrong in principle, *viz*: "Since the diameter *A* is a little more than that of *B*, *C* is revolved slowly in the same direction as *L*."

The diameter of the gears has absolutely nothing to do with the direction of motion of *C*. Gear *A* could be a little more or a great deal more in diameter than gear *B*, or gear *B* could be a trifle or a great deal larger in diameter than gear *A*, and still gear *C* could revolve in either the same or in the opposite direction to handle *L*. It is the numbers of teeth in the gears and not the diameters which control the final movement.

The following is a method for analysis of epicyclic gearing which the writer arrived at many years ago. The method is

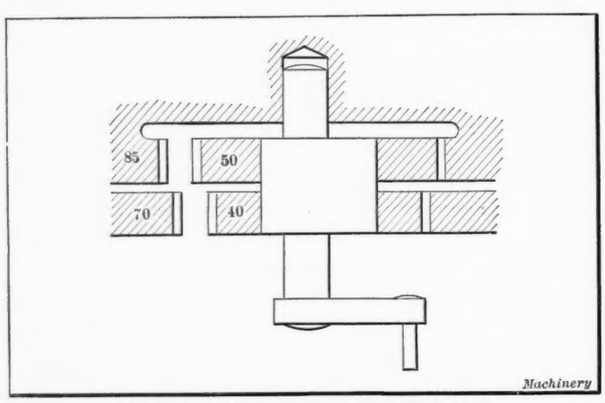



Fig. 1. Type of Speed-reducing Gear Mechanisms

applied in the following to the arrangement shown by Mr. Hurley (see Fig. 1 of the following article). Handle *L* is turned around in, say a right-hand direction, bringing with it eccentric *E*. Gears *A* and *B* are carried around with the eccentric. Gear *D* is fixed to the frame of the machine, and gear *A* moves around the eccentric inside of *B*. Gear *B* makes the same number of revolutions as *A*. Apparently, if gear *C* had the same number of teeth as gear *D*, it would have no movement whatever, because for one revolution of crank *L*, gear *A* will engage with 61 teeth in gear *D*, and gear *B* will engage with the same number of teeth in gear *C*. Gear *C*, however, has 63 teeth, therefore, 2 teeth have been pushed forward out of the way so that these 2 teeth represent the movement of gear *C* in one turn of handle *L*, and as gear *C* has 63 teeth, the movement $= \frac{2}{63} = \frac{1}{31.5}$ of a revolution, or, in other words, handle *L* must make 31.5 revolutions for one revolution of gear *C*. In this particular case, no calculations are necessary as the result can be seen at a glance. It is only when all four gears have a different number of teeth that any calculations are required.

As an example, assume that gear *A* has 40 teeth, *B* 50 teeth, *C* 85 teeth, and *D* 70 teeth, as indicated in Fig. 1. Here *D* has 1¾ times the number of teeth of *A*. If the motion of the crank should produce no motion of the gear *C*, it would be necessary that the latter should have 1¾ times the number of teeth of gear *B*, or $1\frac{3}{4} \times 50 = 87\frac{1}{2}$. Gear *C*, however, has only 85 teeth, hence, 2½ teeth are pushed back for each revolution, and the movement of gear *C* in a reversed direction to handle $L = \frac{2\frac{1}{2}}{85} = \frac{1}{34}$ of a revolution. Hence, 34 revolutions of handle *L* are required to one revolution of gear *C*.

As a final example, we will take the arrangement shown in

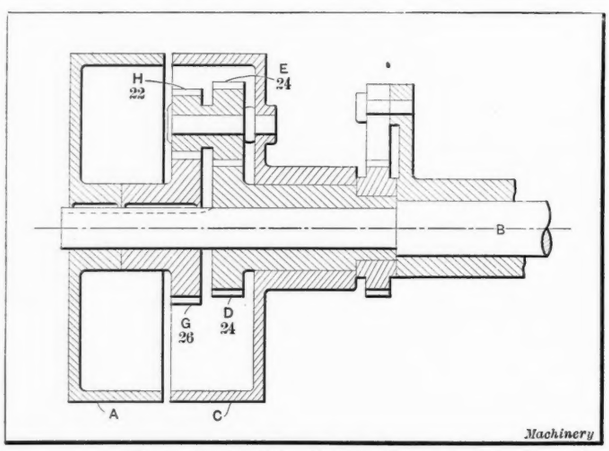



Fig. 2. Another Epicyclic Gear Arrangement

Fig. 2. This arrangement is the well-known two-speed feed-gear, which is found very often on automatic screw machines. When the feed belt is on pulley *A*, shaft *B* is driven at full speed, but when the belt is on pulley *C*, there is a reduction of speed due to the planetary gearing. In order to find the speed reduction and the direction of revolution according to the method given, we first note that gears *D* and *E* are equal. Therefore, we know that if gear *G* had the same number of teeth as gear *H*, no movement would take place. It actually has, however, four teeth more; therefore, four teeth are pushed forward out of the way for each revolution of *C*. As gear *G* has twenty-six teeth, the forward movement for each revolution of *C* is $\frac{4}{26} = \frac{1}{6\frac{1}{2}}$ of a revolution, or in other words, pulley *C* makes 6½ revolutions to one revolution of shaft *B*, the motion being in the same direction.

It is not claimed that the above method will apply to every case, but it will apply to the majority of planetary gearing arrangements, and it has the advantage of being simple and easily applied. RICHARD W. DICKINSON

Pawtucket, R. I.

[The method given by our correspondent is the simplest and so to say, most natural method that can be applied to planetary gearing. Its only disadvantage is that it is liable to cause confusion and mistakes in complicated cases of planetary gearing. In such cases, the safest method, and one which is always applicable, is that given by Mr. Hurley in the October number. —EDITOR.]

## ANALYSIS OF SPEED-REDUCING MECHANISM

The mechanism shown in Fig. 1, reproduced from the article by Mr. S. Hurley in the October number of MACHINERY, is generally known, and is applied to several mechanisms, among others to the well-known Moore's differential pulley block. The analysis is very simple and may be reasoned out as follows: As will be remembered, gear *A*, in Fig. 1, has 45 teeth, 16 pitch; gear *B*, 45 teeth, 18 pitch; gear *C*, 63 teeth,

18 pitch; and $D$, 61 teeth, 16 pitch. The gears $A$ and $B$ are locked together, and as they have the same number of teeth it is evident that for every revolution of crank $L$ the number of teeth displaced in the internal gears $C$ and $D$ will be the same. Since gear $D$ is fixed, it is evident that the movement of $C$ must be the difference of the number of teeth in gears $C$ and $D$ divided by the number of teeth in $C$; hence, the movement of $C = \frac{63 - 61}{63} = \frac{2}{63}$ revolution for every revolution of the crank.

Further, as gear $C$ has a greater number of teeth than gear $D$, it will move in the same direction as $L$. This may perhaps be better understood by referring to Fig. 2, which represents the same kinematic conditions as in Fig. 1. As the gear $D$ is fixed, if we give one revolution to the arm $L$, then $C$ will make

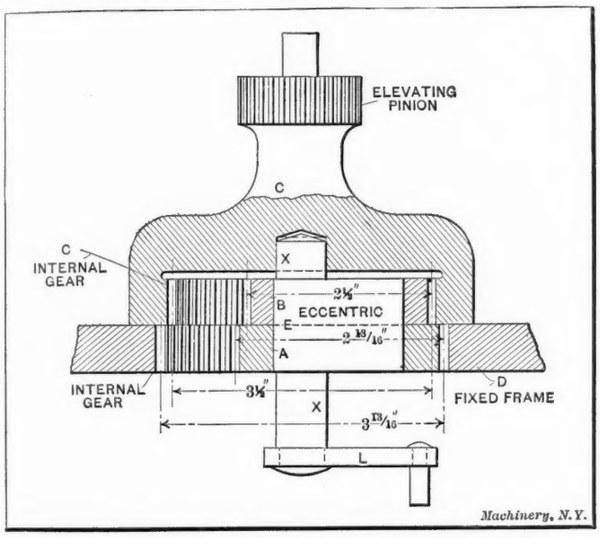



Fig. 1. Epicyclic Gear Train used in Speed-reducing Mechanism

one revolution forward, due to this movement. Due to the train of gearing the movement will be $\frac{D \times B}{A \times C}$ revolutions, and as shown by the arrows in the diagram in Fig. 2, this movement will be opposite to that of $L$. Hence, the movement of $C$ for every revolution of the crank $L$ will be equal to, $1 - \frac{61 \times 45}{45 \times 63} = 1 - \frac{61}{63} = \frac{2}{63}$ revolutions.

G. H. LONGWORTH

Belfast, Ireland.

[The simple analysis above is possible in this case only because gears $A$ and $B$ happened to have the same number of teeth. If these gears had been different, the analysis could

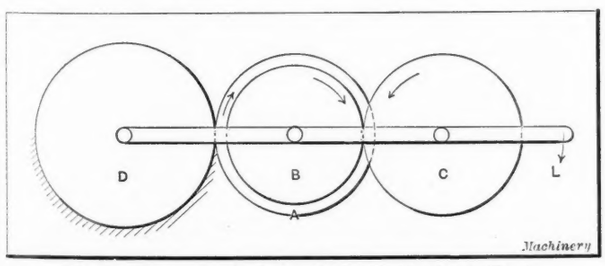


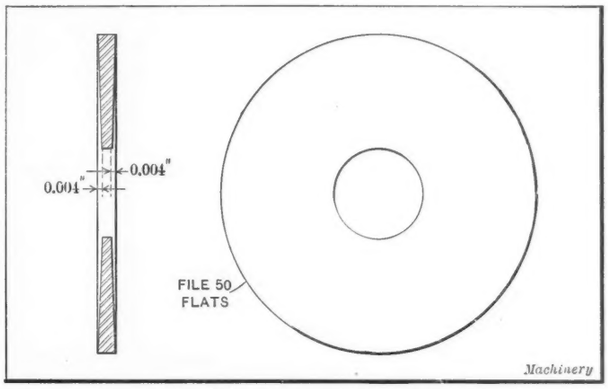

Fig. 2. Diagram for Analysis of Epicyclic Gearing in Fig. 1

not have been so easily made, and the simplest method to employ would then have been the method given in the October number. That method is general, covering all cases of epicyclic gearing, and was therefore given for this special case also.—EDITOR.]

## SLOTTING LOCK TUMBLERS

Having had considerable trouble with the teeth stripping and the saws breaking when slotting lock tumblers, we experimented with different kinds of saws, operating them at various speeds. This, however, did not rectify the matter, so we made a disk 3½ inches in diameter, wide enough to cut the slot in the tumbler. This disk was hardened glass-hard and drawn, the outer edge being left a light straw color. It was then ground tapering on the sides, as shown in the accompanying illustration, to 0.004 inch, to provide for clearance, and placed on an arbor between shaper centers which, in turn, were placed on a magnetic chuck on the grinder. Fifty flats were ground on the edge of the disk, each flat meeting the one next to it.

The tumblers to be slotted were made from brass and cold-rolled steel, and varied from 0.020 to 0.050 inch in thick-




Friction Disk for Slotting Lock Tumblers

ness. The pulleys on the overhead works for the sawing machine were changed, so that the disk was rotated at 1600 R. P. M. This disk cut the tumblers like cheese and did not leave any burrs; it could also be used for weeks without grinding.

W. C. BETZ

## DIES FOR DRAWING A DEEP STEEL SHELL

Little information has appeared in the technical press on the subject of drawing dies, and the writer considers that this line of work is only in its infancy. A large majority of work which

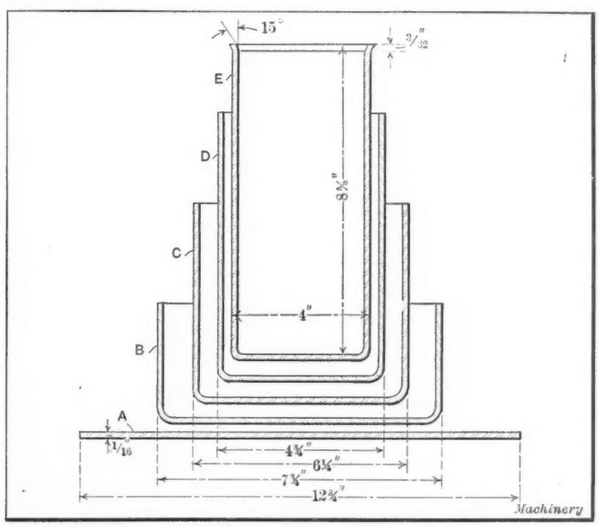



Fig. 1. The Blank and the Successive Drawing Operations

was previously made from castings can now be made from sheet steel by drawing up bosses and reinforcing ribs to strengthen the work. In our shop we recently completed a set of drawing dies for producing a steel can 4 inches in diameter and 8⅝ inches long, with a 3/32-inch shoulder formed at an angle of 15 degrees with the sides. Fig. 1 shows the blank $A$ and the successive drawing operations. The blank is made from sheet steel, 1/16 inch thick, and is 12 3/4 inches in diameter.

The first drawing or cupping die is shown in Fig. 2, and the cup produced in this die is shown at $B$ in Fig. 1. The die bed $A$, Fig. 2, is made from cast iron, while the drawing die $B$ is made from machine steel, pack-hardened. The punch $C$ is also made from machine steel, and pack-hardened, and the blank-holder $D$ is made from cast iron, faced with a hardened machine-steel ring $E$. The cup is stripped from the punch by

means of the finger *F*, acted upon by the spiral spring shown.

The construction of the second drawing die, shown in Fig. 3, is substantially the same as that shown in Fig. 2, except that it is provided with a gage-plate *G* for holding the cup. The length of the shell produced by the die shown in Fig. 3 is indicated at *C* in Fig. 1. After these two drawing operations the shell is annealed, and then put through the die shown in Fig. 4. The construction of this die is similar to that shown in Fig. 3, and therefore needs no description.

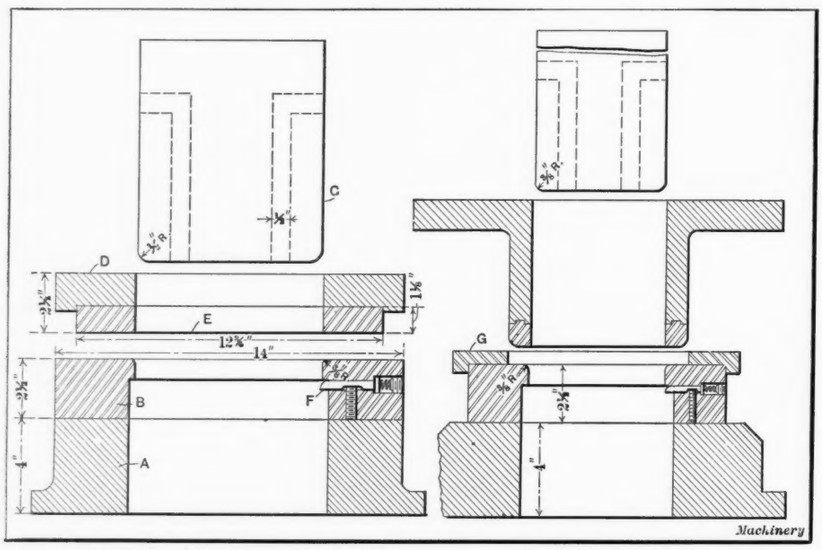
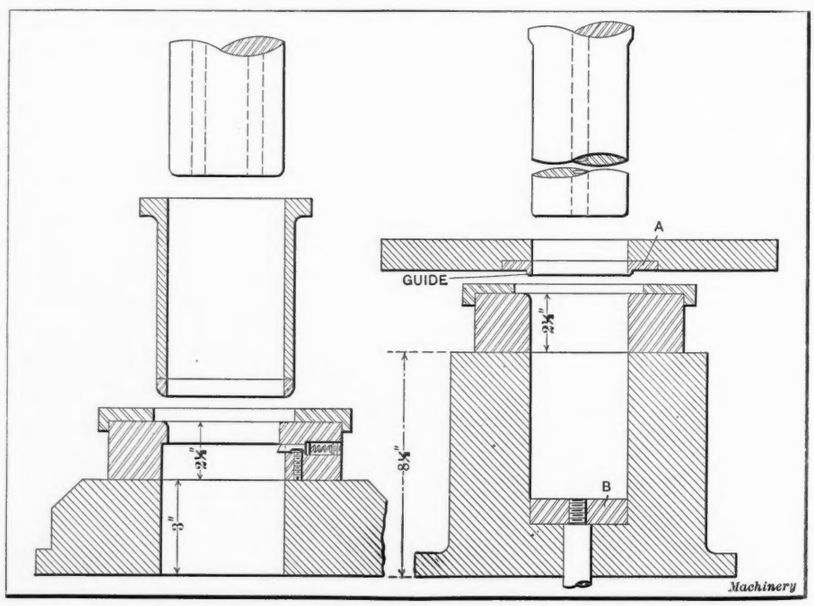



Fig. 2. Punch and Die for Forming the Cup

Fig. 3. Punch and Die for Second Operation

The cup *D*, after the third drawing operation, was too long to be inserted in the press for the fourth drawing operation, and had to be trimmed down to 7½ inches. The shell is kept in an upright position in the die, Fig. 5, by a ring gage or guide *A*, which fits in the top of the shell when it is located in the die, and holds it while the punch forces it through. The distance between the bed and the ram of the press was not sufficient to allow the use of this guide without trimming the shell, which operation could have been dispensed with if a suitable press had been available.

The shell was annealed after the third drawing operation, and then put through the finish-drawing die shown in Fig. 5, after which it was trimmed to the required length. The last drawing die, Fig. 5, is provided with a knockout *B*, which was necessary, as it was impossible to force the shell through the die in this operation, on account of the punch forming a flange on it, as shown at *E* in Fig. 1. All the drawing punches were provided with air passages, and the drawing faces of the blank-holders were made from tool steel and hardened. THOMAS ALMA




Figs. 4 and 5. Punches and Dies for the Third and Fourth Drawing Operations

## THE VALUE OF THE SCLEROSCOPE

No doubt most readers of mechanical magazines have heard about the scleroscope, and probably have used it with satisfactory results. My experience with this instrument is very favorable and I could write much about it, but will only give those instances which best serve to show its advantages. It seems rather queer to me that steel houses do not equip their warehouses and salesmen with the scleroscope. It undoubtedly would settle all disputes in delivering steel, etc. On the other hand, some salesmen wish that it had never been invented, for the reason that it is somewhat of a "judge," and steel is often returned because it is found by the scleroscope not to be as represented. This is where the instrument gets in its good work.

My experience has demonstrated that the scleroscope when used on annealed steel will give almost the exact working results of the steel when in the hardened and tempered state. There is a great saving of time in testing annealed steel, as it does away with the work of cutting off samples, hardening, drawing, breaking, and crystallizing to find the carbon contents, etc. Of course, the latter method is all right, but the use of the scleroscope is much simpler. We have used it a great deal on hardened stock, but only in tempering, because when the quality of the steel in its annealed state is known, the temper to which it should be drawn is easily obtained. Sometimes steel that is sold for high-carbon steel is found to be low in carbon.

A few years ago we could judge approximately the carbon contents of steel, but now we can tell it exactly. Drop dies for lock keys must be made from high-carbon steel in order to harden as much as possible in the center of a 2- by 3-inch bar. Carbon steel striking 33 to 35 (by the scleroscope) in the annealed state is the best, and 2- by 3-inch stock will increase about 10 points in the center after hardening, which is just sufficient to keep the die-block from sinking. This grade of steel can be drawn to a purple color and will give good service, but a piece of 2- by 3-inch stock striking from 28 to 30 will not harden in the center at all, leaving a crust that settles down into the soft center with the blow of the drop hammer, and after a few blows cracks. Some salesmen will say, "We have a steel that will suit your purpose." They send us a sample piece of ½-inch by 2-inch by 3-inch stock, and it strikes about 37. Here is a good point to remember: Do not trust to their annealing; anneal it yourself and you can get the actual quality of the steel. After annealing, this same piece would probably strike 33, but more often 28 or 29, which indicates that it is low in carbon. A piece of steel should strike at least 30 to make any ordinary tool that will give good results.

It seems difficult now to get high-carbon steel for special work. Perhaps the reason is that there is so much alloy steel on the market (which is all right in its place) that the steel warehouses do not carry a large amount of high-carbon steel.

For making key dies, straight carbon is the best. We have tried a great many different grades of steel for this particular work, but have come to the conclusion that the regular high-carbon steel is the best if properly tempered. If manufacturers and warehouses would sort their steel with a scleroscope it would place the selling of steel on a sound basis.

This brings to my mind an article which I read some time ago in one of the technical magazines about a Mr. Jackson having considerable trouble in hardening steel uniformly, although he had all the best and most modern equipment, pyrometers, etc. Mr. Jackson took a trip to see how the steel was made at the mills with the hope of finding the cause of his trouble. He watched the "headlooker" peer into the furnaces and wondered how he was gaging the different heats, so he asked what pyrometers they used; but that was a new one on them as they had never even heard of such an instrument, and were sure that there were none about the place. He then began to wonder why he should use such a good equipment when at the steel mills the steel was made by the eye alone, which seemed more like guesswork than the methods he was using. It may be inferred from this that the makers and warehouses do not generally use the scleroscope; if they did it would be better all around.

New Britain, Conn. J. W. DICKINSON

## DRAFTSMEN'S DIFFICULTIES IN FOLLOWING HEALTH RULES

The article "Physical Health and Drafting" in the November number of MACHINERY contains a great deal of truth, and if the rules could be followed absolutely, much good would result. However, it seems to the writer that some of the statements as to the proper posture that a draftsman can maintain are slightly erroneous. The author says that many draftsmen begin their day's work by tying a small apron about their waist to protect the clothing from being rubbed, but points out that the draftsman's work does not really call for the use of the abdominal portion of the body to correctly fulfill his duties; yet, it is practically impossible to follow this occupation without submitting that portion of the body to considerable pressure. The theory of proper posture is very good and it is obvious that serious results may follow if it is entirely neglected, but the draftsman, however willing he may be to aid nature in preserving his health, finds it incumbent upon him to produce the work, and to this end he must assume positions which at the best are extremely uncomfortable. This is especially true on large drawings; for although, as suggested in the article referred to, the draftsman may rest his knees on his stool, any draftsman who has tried this, especially on a revolving stool, knows how incompatible this position is with rapid work and comfort. The advice to assume a sitting position on the board is practically impossible to follow on all adjustable tables.

The average height of the front edge of the majority of drafting tables is perhaps about 3 feet 6 inches, with the back edge 4 or 5 inches higher. A man of ordinary height, standing or sitting at a non-adjustable table of this height will be able to assume a proper posture and work over any small drawings, but when any part of the work exceeds a distance of 15 inches from the edge of the table, he cannot do the work and keep clear of the edge. When drawing horizontal lines on accurate work by means of the T-square, he must lean over until the eye is vertically above the line to be drawn. Hence, with a table 38 or 40 inches in width, this means that when a draftsman is working on a drawing that is nearly the full width of the table, he must lean over the edge at least 20 inches, even if the work is accessible from all sides, which unfortunately is not often the case. The advice which is given in the article referred to is often given in class-rooms by drawing instructors. This can be followed on the small drawings with boards to suit which are here used, but the argument loses a great deal of its force when applied to practical work. Many drafting-rooms, even in large plants, have tables which cannot be moved or adjusted in any manner, and the stools are often of a fixed height—consequently the draftsman must make the best of the situation.

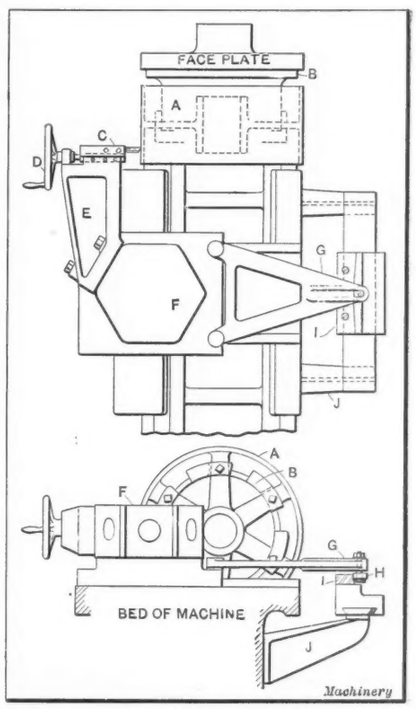
The writer has found that the arrangement shown in Fig. 1 of the previous article, with the drawing tables placed with the left end towards the window and the table a little back of the direct line of the window, is not as satisfactory as when the table is put a little ahead of the direct line of the window. When in this position there is no glare of light shining in the face of the draftsman, and the light falls on the board at an equally good angle. The ribbed glass windows that are installed in some places give a most excellent distribution of light and rest the eye from the tiresome glare.

In articles referring to the health of draftsmen, a point rarely mentioned that affects many men, is the habit which some draftsmen have of going out into the shop without putting on any additional clothing. In many places the draftsman frequently goes out into the shop without putting on a coat and head covering, although he passes directly from a warm room to what is in many cases a cold shop. The writer has known of two cases of bad colds, followed by pneumonia, that were laid to this cause.

Hamilton, Ohio. J. B. HASKELL

## PULLEY-CROWNING ATTACHMENT

In articles referring to the health of draftsmen, a point the writer is connected made an attachment adapted to a Bullard lathe, consisting of a radius bar pivoted at its outer end; this connection, attached to the cross-slide, caused the turret to swing through an arc of the desired radius, as the carriage advanced, crowning the pulley. This proved quite satisfactory for pulleys of small size, but when it was attempted to crown large pulleys, it was found that a sufficiently large radius could not be obtained.



Pulley-crowning Attachment for Bullard Turret Lathe

The accompanying engraving shows the manner in which the difficulty was solved; the attachment is designed to accommodate pulleys of all sizes within the capacity of the lathe. Pulley *A*, to be crowned, is attached to the faceplate by a jig *B* which clamps over the pulley arms, the pulley being slipped on and then swung through a part of a turn under the clamps and there secured. A tool is mounted on a carriage *C*, this carriage being fed forward by handwheel *D* on ways in a bracket *E*, which is bolted to one of the faces of the turret head *F*.

Secured to the cross-slide of the lathe at the side of the turret head is a bracket *G*, carrying on its outer end a roller *H*. The outward pressure between the work and the tool keeps this roller *H* in contact with a form or crowning shape *I*, supported at the rear of the lathe by brackets *J*. The form *I* is detachable and may therefore be replaced at will by the desired shape to give the correct crown. The form is of the exact shape and size of the crown to be produced. To keep the roller on the form, in taking a light cut, a guide should be placed on the other side of the roller.

The bracket *G* is slotted so that the turret can be brought nearer to the center line of the lathe when it is necessary to crown small pulleys; this is accomplished by loosening the bolt and nut which hold *G* and *I* together.

Ashburnham, Mass. K. P. ALBRIDGE

## SYSTEMS OF DIMENSIONING DRAWINGS

After reading Mr. I. E. Hall's article on "Systems of Dimensioning Drawings," in the November number of MACHINERY, the writer finds himself moved to make a few comments on this subject. Mr. Hall points out that there are four different systems in use for dimensioning, and recommends using a system made up of both common and decimal fractions, because in so doing it is possible to indicate to the mechanic whether a piece of work must be made very accurately or only approximately to size.

The limitations of this system are that the method of dimensioning does not in any way indicate the actual limit of accuracy that is required. More attention should be given to this point. It is just as important to show some limit of accuracy, as it is to show whether a piece has to be made accurately or not. Is the mechanic to work to a limit of 0.0005 or 0.001 inch every time the dimension is given in decimals? Some method should apparently be devised so that the limits of accuracy could be indicated more directly.

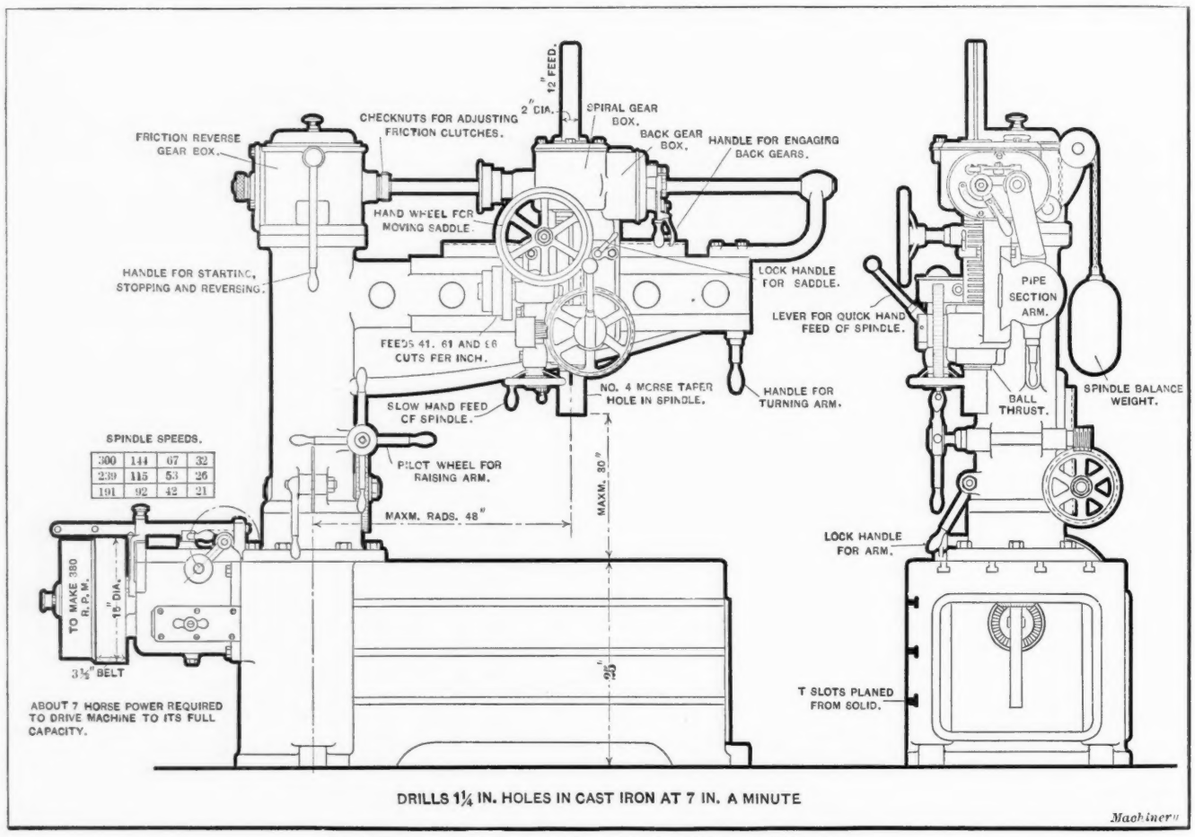
A satisfactory system using nothing but decimals can be adopted which will give the limits to which a piece of work should be finished, the limits being indicated by the number of decimal places used. For example, assume that a certain pin is to be 7/8 inch long, and that the exact length is required; the dimension then would be written 0.8750 inch. Now say that a limit of 0.001 inch over or under the exact size is permissible; this would be shown by writing the dimension 0.875 inch. Again, if a limit of 0.005 inch is allowable, then we would write the dimension 0.87. By the use of certain limits corresponding to the number of decimal places shown on the drawing, it will be possible to see at a glance what is required. The limits adopted to correspond to a certain number of decimal places are, of course, arbitrary, and can be adopted to suit the particular work handled in each shop. For example, four decimal places may indicate a limit of 0.0005 inch above or below; three decimal places, 0.001 inch above or below; and two decimal places, 0.005 inch above or below. It is good practice to place a table of limits right on the drawing on some space provided for that purpose.

In some cases it is necessary that certain work must not be over a certain size, but it can be somewhat smaller. In that case all we would need to do would be to write the dimension 0.875—; this would at once show that the piece must not be longer than 0.875 inch. If the piece could not be shorter than 0.875, but might be somewhat longer, the dimension should be written 0.875+. Of course, the system outlined applies only to shops where a line of accurate work is to be done, but in such shops the system will be found better than any other. It tends to eliminate errors and greatly facilitates the work.

Kingston, Pa. H. J. SCHMIDT

## METHOD OF MAKING TENDER DRAWINGS

When buying a machine, a drawing is of great assistance in helping one to arrive at the merits of the various devices and mechanisms of which the machine is composed. Similarly, if one is trying to sell machines, a drawing is the best medium by which to convey the good points of the machine to the prospective customer. It is safe to say that of two machines, other things being equal, the one which is illustrated by the neatest drawing will stand the better chance of securing the order. There are many styles of drawings used for tendering purposes, ranging from the common or garden variety, in which all the lines are of equal thickness, to the elaborately shaded productions which necessarily take a tremendous amount of time to make.


FRICTION REVERSE GEAR BOX.
CHECKNUTS FOR ADJUSTING FRICTION CLUTCHES.
2" DIA.
12 FEED.
SPIRAL GEAR BOX.
BACK GEAR BOX.
HANDLE FOR ENGAGING BACK GEARS.
HAND WHEEL FOR MOVING SADDLE.
HANDLE FOR STARTING, STOPPING AND REVERSING.
LOCK HANDLE FOR SADDLE.
LEVER FOR QUICK HAND FEED OF SPINDLE.
PIPE SECTION ARM.
FEEDS 41, 61 AND 16 CUTS PER INCH.
NO. 4 MORSE TAPER HOLE IN SPINDLE.
HANDLE FOR TURNING ARM.
BALL THRUST.
SPINDLE BALANCE WEIGHT.
SLOW HAND FEED OF SPINDLE.
SPINDLE SPEEDS.
300 144 67 32
239 115 53 26
191 92 42 21
PILOT WHEEL FOR RAISING ARM.
MAXM. 80"
MAXM. RADS. 48"
LOCK HANDLE FOR ARM.
TO MAKE 380 R. P. M.
15" DIA.
3½" BELT
95"
ABOUT 7 HORSE POWER REQUIRED TO DRIVE MACHINE TO ITS FULL CAPACITY.
T SLOTS PLANED FROM SOLID.
DRILLS 1¼ IN. HOLES IN CAST IRON AT 7 IN. A MINUTE
Machinery

Tender Drawing of a "New Model" 23-inch Radial Drilling Machine

The method we have adopted seems to be about as good as anything I have seen, and it has the advantage of not taking a fraction of the time that would be required to make a shaded drawing, with which, for effectiveness, it compares very favorably. As shown in the accompanying engraving, reproduced from the tracing, the outlines of the machine are heavy lines (about 1/16 inch in this particular instance). The effect of these heavy outlines is to give the drawing a more substantial appearance; the machine stands out more and gives the observer a better idea of its general appearance. Of course, liberal notes explaining the various "points" of the machine are necessary if the drawing is to be thoroughly effective.

Keighley, England. ALBERT CLEGG

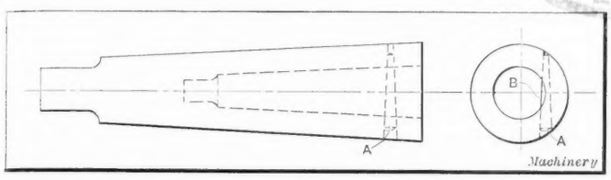
# SHOP KINKS

**PRACTICAL IDEAS FOR THE SHOP AND DRAFTING-ROOM**

**Contributions of kinks, devices and methods of doing work are solicited for this department. Write on one side of the paper only and draw sketches on separate sheets.**

## A DRILL SOCKET FOR HOLDING DRILLS WITH BROKEN TANGS

In the October number of MACHINERY I noticed a drill socket for holding broken tangs. I have tried one similar to it, but the drill socket shown in the accompanying illustration is, I think, much better.

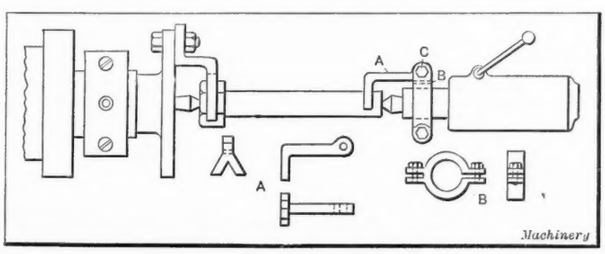



The tapered pin *A*, filed flat on the inside at *B*, is driven into the socket as shown; then a corresponding flat is filed on the shank of the drill until it fits in the socket. This pin holds the drill very effectively.

Wadsworth, Ohio. EDWARD ALLAN

## DEVICE FOR LOCATING WORK ON THE LATHE CENTERS

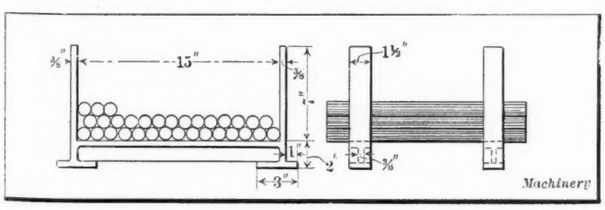
In shops where large quantities of work similar in character are to be turned out, the piece-worker, in order to make good, must devise means to expedite the work. Devices which would be impracticable in a jobbing shop, would, in many cases be applicable to a shop in which piece-work is done. The accompanying illustration shows a simple device for locating work on the lathe centers, applied to a hexagon-head bolt. A U-clamp is fastened to the faceplate, as shown,




acting as a driver, and a swinging V-guide *A* is held in a split ring *B*, which is clamped to the tailstock spindle. This device prevents the workman from forcing the tail-center into the end of the work instead of in the center prepared for it, and it also enables him to locate the work more quickly on the centers. The V-guide can be quickly adjusted or drawn out of the way by releasing the clamp screw *C* so that one V-guide will cover a large range of diameters. M. B. H.

## A SHAFT RACK

In piling up shafts on a work bench I have often noticed that nails are used to support the shafts and keep them in position. Very frequently the weight of the shafts upon one another causes them to spread, and the shafts roll down on the floor. To overcome this difficulty the shaft rack shown




in the accompanying illustration was made. It consists of two cast-iron brackets, which can be placed the required distance apart. By using these brackets more shafts can be piled in less space than is usually required. The rack shown is made to hold 100 one-inch shafts, requiring a space 15 inches long by 7 inches high.

Hartford, Conn. J. E. COOLEY

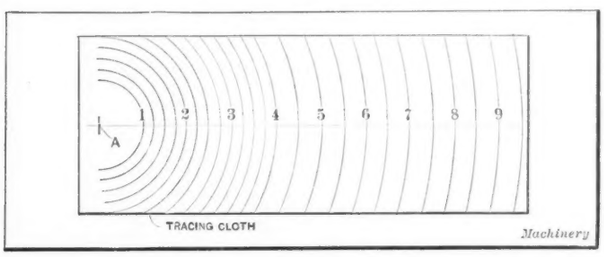
## PREVENTING A FILE FROM SCRATCHING

When using a new file, especially in the lathe, it is sometimes found to scratch and produce an undesirable finish. This can be obviated by taking an oilstone and rubbing it over those parts of the file which are doing the scratching. This kink is not very well known, and may be of value to those having much filing to do in the lathe.

Norristown, Pa. GEORGE OELSCHLAGER

## MEASURING IRREGULAR CURVES

It is common practice in most drafting-rooms to dimension all curved portions of machine webs, legs, etc., in order to assist the patternmaker in laying out the curves accurately. I used to find this a tedious task, chiefly when the curves were very irregular, but hit upon an idea which entirely eliminated the difficulty. This idea consists mainly in taking

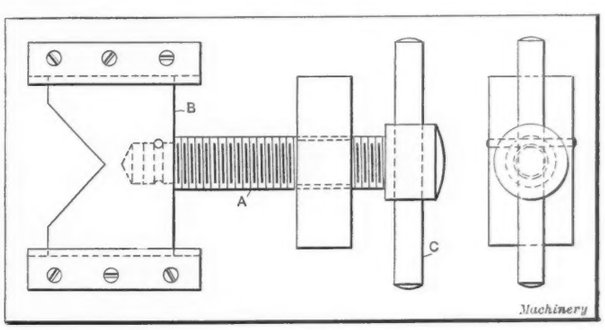



a piece of tracing cloth, describing a series of arcs upon it, and drawing a center line as shown in the accompanying illustration. The size of this chart, of course, depends entirely upon the character of the work.

The method of applying this chart is as follows: Place it on the drawing in such a position that one of the arcs will coincide with the one to be measured. Now to find the center of the arc prick through the center *A* of the chart. This gives the center of the arc which can then be read direct. J. L.

## CUTTING A GROOVE IN A SWIVEL SCREW WITH A DRILL

The accompanying illustration shows a simple means of cutting a groove in a swivel screw which is placed in a sliding V-block. The groove, of course, could have been cut in the lathe, but as there was no lathe handy at the time, the writer struck on the following method: The screw *A* was placed in the hole in the sliding block *B*, up against the shoulder, and




a hole was drilled clear through the block and screw, half in each. The drill was then raised until the point was on a level with the center of the screw, when the latter was turned to the left by means of handle *C*. The point of the drill then acted as a mill, cutting a groove in the turned portion of the screw.

Springfield, Mass. R. A. CLAPP

In soldering it is often desirable that the surfaces should tin only to certain boundaries. If it is possible to put a fine copper wire or thin copper strip at such points, the solder will not flow beyond. GEORGE W. ARMSTRONG

# SHOP RECEIPTS AND FORMULAS

## A DEPARTMENT FOR USEFUL MIXTURES

**This page is intended to be used only for the publication of such shop receipts as the contributors know from experience to be practicable. Receipts are solicited on the condition that the contributors personally know that they are reliable. The fact that a receipt is old and supposedly well-known does not bar it, provided it has not already appeared here.**

### COMPOUND FOR PIPE CONNECTIONS

I have found shellac to be a very satisfactory substitute for lead in sealing air and gas pipe connections. It is applied with a brush to the joints and hardens very rapidly, and being brittle, the pipes can be readily disconnected. S. C. S.

### HARDENING SOLUTION FOR TOOL STEEL

The following hardening solution will be found satisfactory for hardening crucible tool steel which has a carbon content of about 0.90 per cent or 90 points. This solution has been found especially valuable for hardening such tools as punches, stamps, heading bunters, etc., and, in fact, any tool which has to resist wear and compression. In hardening, the tool is heated to a cherry red, about 1652 degrees F., then dipped in the following solution, which consists of: sal ammoniac, 4 ounces; alum, 4 ounces; common salt, 3 pounds; water, 6 gallons. The solution should be kept in an earthen-ware jar and covered to prevent dust or other foreign matter from collecting in it; it should also be well mixed before using. M. G.

### A HARDENING SOLUTION

The following hardening solution will be found suitable for hardening small tools, such as taps, dies, etc. Pieces hardened in this solution are made extremely tough and will withstand considerable pressure. The solution is as follows: To 15 gallons of water add 1 pound of cyanide of potassium, 6 pounds of saltpeter, 2 pounds of common lime, ¾ ounce of permanganate of potash. Distilled water if it can be obtained should be used, but rain water if pure and clean will also answer the purpose, although distilled water is better. Before dipping the tools they should be heated to a cherry red, and when dipped in the bath they should be kept moving, so that they will harden uniformly. It is not necessary to draw the temper after hardening.

Plainfield, N. J. JOS. R. WEANER

### LUBRICATING WORMS AND WORM-WHEELS

Worms and worm-wheels under heavy duty often wear out quickly when run dry, or when lubricated with common machine oil. Cases have been known where worm-wheels gave out in three weeks' time when lubricated with ordinary oil, and when supplied with a special lubricant, ran continually with no perceptible wear. The following is a compound which has been used with satisfactory results for this purpose:

To one gallon of prime lard oil, add 1½ gallon of steam cylinder oil, one 1-pound package of Dixon's graphite, and 2 quarts of flowers of sulphur. Mix this compound thoroughly and keep the worm almost entirely submerged all the time.

M. W. W.

### SOLDERING ALUMINUM

Although there have been various methods given for soldering aluminum, I offer no apology for adding another to the list. The constituents of this solder and the method of using it have the advantage of several years' test.

To prepare the solder, melt half a pound of phosphor tin in a ladle, and add to this half a pound of zinc. With the aid of a wooden stick, stir in a half a pound of beeswax, after which put in half a pound of block tin. Mix the molten metal well, and cast into strips. If mixed according to these directions, there should be no difficulty in soldering aluminum, either to another piece of aluminum or to a different kind of metal.

When using, clean the articles to be soldered, and tin them with the above solder in the usual way, but do not use a flux. If it is required to fill up a blow-hole, this can be done after tinning, by using any ordinary solder. When joining aluminum to another metal, it is only necessary to use the special solder on aluminum, as ordinary solder and methods can be used on the other metal. A. E. D.

### OIL AND WATERPROOFING BLUEPRINTS

A cheap and effective agency that will resist water and oil, is made by dissolving paraffine in gasoline. Take a large mouthed bottle and shave into it some paraffine—the large, yellowish and greasy coach candles furnish the best—to the depth of about one-fourth of the bottle; then fill the bottle with gasoline, and shake occasionally until the paraffine is dissolved.

Now, lay the prints on a flat surface, pour on a small quantity of the solution, spreading it with a paint brush until the paper has absorbed all that it will hold. At first the paper will be transparent, but as soon as the gasoline dries, the paper will resume its natural tone. When about half the gasoline has evaporated, the surplus solution should be wiped off with a clean, soft cloth or else there will be a white coating of paraffine left on the paper, which would be objectionable, the body of the paper having absorbed enough to render it impervious to water and grease. Below a temperature of 60 degrees F., the solution coagulates, when it must be warmed to again reduce it to a liquid. In making and using, the solution must be kept away from fires. H. W. WEISGERBER

Salem, Ohio.

### REMOVING SPOILED NICKELING

While in many cases nickel-plated articles are so cheap that it would not pay to remove the nickeling in case this did not turn out well, there are cases where this would sometimes be found desirable. The best process for doing this, says the *Allgemeine Schlosser Zeitung*, is to abrade the coating with emery powder and then proceed as usual to replate. For iron and steel articles this is the best method which can be employed. For articles made of brass, copper, German silver or Britannia metal, an acid bath may be used to remove the plating. The requisite bath consists of 27 parts, by measure, of oil of vitriol (fuming sulphuric acid) and 18 parts of nitric acid. The articles to be cleansed must first be freed from fat by dipping them in lye, the same as for newly plating. This assures regular action of the acid bath. The article is moved about in the latter until all the nickel is dissolved; it is then rinsed first in hot and afterwards in cold water. The acid attacks the base, also, but polishing will restore its original appearance.

Dresden, Germany. ROBERT GRIMSHAW

### MIXTURE FOR HARDENING TOOL STEEL AND CASEHARDENING MACHINE STEEL

The following mixture will be found suitable for hardening gages or similar tools made from either tool- or machine-steel. Tools hardened in this mixture do not warp or change shape to any perceptible extent, and thus it should be appreciated in the tool-hardening department. The compound consists of: five parts of potassium prussiate [$K_3Fe(CN)_6$] and eight parts of potassium carbonate ($K_2CO_3$). To prepare, the potassium prussiate should first be thoroughly melted in an iron pot, after which the potassium carbonate should be added. These two constituents should be well mixed. When the mixture is not in use, it should be covered to exclude dirt or other foreign substances.

In using, put the pot in the forge and pack it up well with coal, so that it will be heated evenly. Before the mixture is heated, drop the pieces to be hardened into it, and cover them up. When heated sufficiently, remove the pieces and dip them in either water or oil. Water is used where the tool is not of a delicate nature, but where the work is slender, oil is preferable; a good grade of lard oil gives the best results. Extra precautions should be taken when using this compound not to get any water near it, or an explosion will result.

This same mixture can be used for casehardening machine steel, with very good results. Some manufacturers have found it advisable to make gages of machine steel and harden them in this way. When a tool is hardened in this mixture, it is given a nice mottled appearance.

G. MURRAY

# NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

## J. N. LAPOINTE BROACHING MACHINE

The J. N. Lapointe Co., Marlboro, Mass., is manufacturing an improved design of broaching machine which is capable of handling work ranging in size from the smallest to the heaviest parts that it is practicable to broach. This machine is illustrated in Fig. 1. The pulling mechanism consists of a sliding head operated by a 2¾-inch screw passing through the hub of the main gear in which a special composition nut is inserted in such a way that it can be quickly removed for replacement when necessary. In order to overcome the friction and increase the power of this machine when the load is applied, a large ball thrust bearing is placed to receive the longitudinal pressure.

The machine has a positive geared drive and return and is arranged with two speeds in order to suit the various classes of work. The speed is changed by a sliding gear connected direct to the driving gear. The driving mechanism is of simple construction throughout. No pins or positive clutches are used in the drive, and the machine can be run at any speed desired without injury. The screw which operates the sliding head telescopes into a tube attached to the rear end of the machine, in order to protect it from dust accumulated by the belts. Under the front end of the machine there are two lugs to which a special supporting table or other holding fixtures can be fastened by means of screws, in case such fixtures are necessary. These special appliances are connected under the table instead of to the face of the machine, to avoid interference when connecting the broaching tools. This machine has been successfully used for broaching 1½-inch holes in steel castings 15 inches long, which illustrates its pulling power. It is equipped with an automatic oil pump for lubricating the work and a countershaft.

Fig. 2 shows a number of broached parts, and the following data relating to this work will doubtless be of general interest. Part *A* has a ⅞-inch square hole 1½ inch long which is finished in one operation by the use of one broach at the rate of thirty-five to forty-five per hour. Four ¼-inch rivet grooves are cut in part *B* in one operation at the rate of about one hundred pieces per hour. The blank is ¾ inch thick and three pieces are broached simultaneously. Part *C* has a 1¾-inch square hole 1¾-inch deep, with "round corners," and it is done in two operations by the use of two broaches at the rate of about twenty per hour. Ten ¼-inch keyways 1¾ inch long are broached in part *D* in one operation at the rate of about thirty-five per hour. Part *E* is an internal gear 3 inches in diameter and ⅞ inch thick, and it is broached in one operation. Two gears are finished at a time, and the rate is sixty per hour. Part *F* has a 1½-inch square hole 4 inches long, which is broached by two roughers and one short finishing broach at the rate of about ten to twelve pieces per hour. The nickel steel blank *G* is broached by three roughing and one short finishing broach at the rate of about six per hour. The data for part *H* is similar to that given for part *C*. The toolpost *I* has a slot ⅝ inch by 2½ inches, which is finished by a roughing and finishing broach at the rate of about twelve to fifteen pieces per hour, the hole being first jig drilled to admit the broach. Part *J* has four ⅜-inch keyways cut in a 1-inch hole 1¾ inch long, in one operation at the rate of thirty to thirty-five per hour. A 2-inch square hole 2½ inches long, with "flat corners," is broached in part *K* in two operations at the rate of twelve to fifteen per hour. Part *L* has four ⅜-inch keyways cut in a 1⅜-inch hole 2 inches long, in one operation at the rate of about thirty per hour. Wrench *M* has a 1¼-inch hexagonal hole which is finished with one short broach at the rate of thirty-five to forty pieces per hour. Part *N* is a nickel-steel universal-joint blank 5 inches in diameter and 1¼ inch thick, having four rectangular holes broached so as to be equi-distant from a bored central hole within a limit of 0.0015 inch. These holes are forged with ⅛-inch stock left for broaching, and they are finished to a width of ¾ inch and a length of 1¾ inch. This work can be done either by the use of twin broaches, that is by operating two broaches at a time, or by using a single broach mounted in a work bushing or fixture so as to hold it in the proper position. The production depends upon the method employed, but, generally speaking, these blanks can be broached accurately at the rate of about four or five per hour. The wrench *O* is done in practically the same manner and at the same rate of production as listed for wrench *M*.

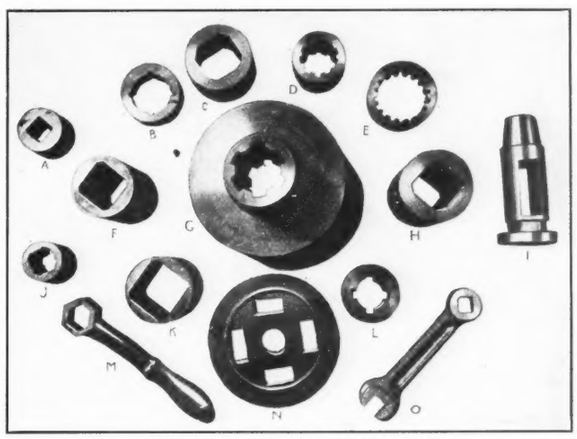



Fig. 2. Examples of Broached Work

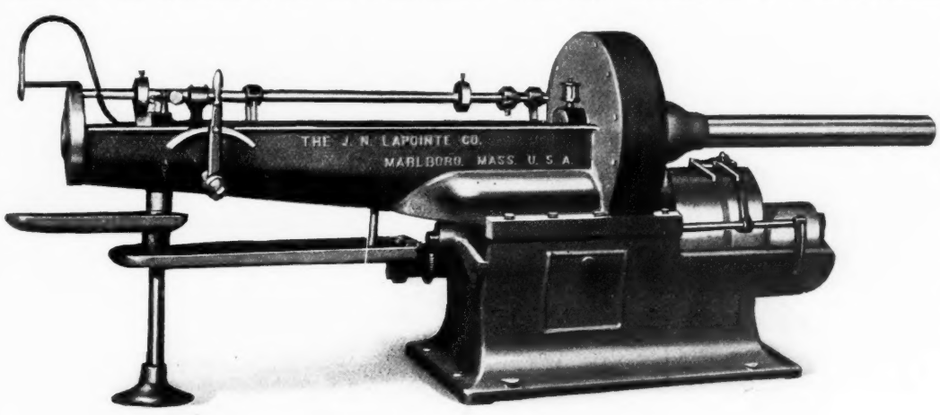
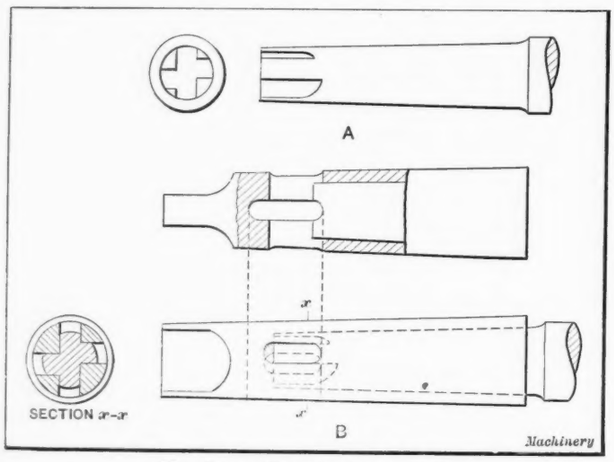



Fig. 1. Lapointe No. 3 Broaching Machine

## GROSS DRIVING TANG

The Morse taper shank which is shown at *A* in the accompanying line engraving has a new form of tang drive, brought out by Elmer S. Gross, Harrisburg, Pa. By referring to the end view, it will be noted that the tang differs from the common form in that there are additional side tangs which are offset from the center. The form of sleeve or socket used with this style of tang is illustrated at *B*. This sleeve has the usual cross-slot with clearance above the tang for a drift-key and, in addition, shorter cross-slots offset to correspond

with the side tangs. The relation between the tang and socket is clearly shown in the sectional view $x$—$x$ to the left. A taper shank drill or other tool having a common flat tang, can be inserted in this socket. It is claimed that by offsetting the side tangs, a more rigid construction is obtained,




New Form of Drive for Tang-driven Tools

and this feature also has the advantage of presenting a larger portion of the socket, on the driving side of the extra slots, when using tools having ordinary tangs.

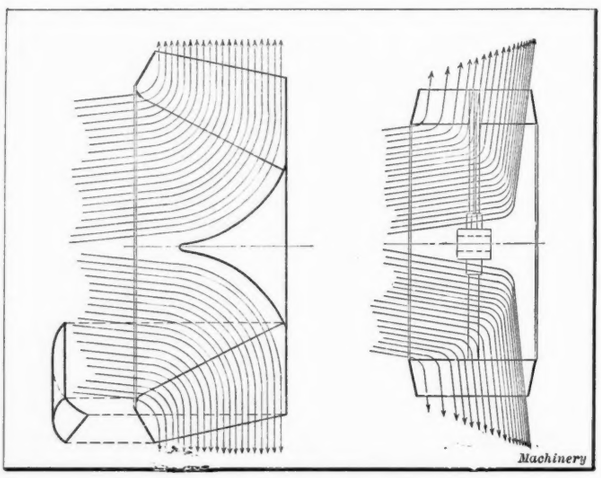
## CONOIDAL MULTI-BLADE FAN

A fan has been developed by the Buffalo Forge Co., Buffalo, N. Y., the blade construction of which gives the wheel the shape of the frustrum of a cone. The inlet is on the side corresponding to the base of the cone, as shown in Fig. 1 of the accompanying illustrations. The prevalence of

Fig. 1. Multi-blade Fan built by Buffalo Forge Co.

conical shapes in the design is responsible for the name "Conoidal," which has been given to this fan. It is claimed that this new design, as compared with a centrifugal fan, has higher efficiency and requires less space for a given capacity. The efficiency curve is said to remain practically constant for a total range of nearly 60 per cent, thus permitting a load of approximately 30 per cent above or below the regular capacity with little loss of efficiency. The blades of this fan, instead of having parallel edges, are slanting so that the inlet side of each blade is much narrower than at the rear, thus giving an inlet of large diameter.

The action of the air when passing through this fan is illustrated by the diagram, Fig. 2. As the air is drawn in through the inlet it is gradually deflected by a central conical hub towards the blades, which are so arranged in regard to curvature, inclination to the axis of the wheel and increasing width towards the driving side, that the air is delivered by the entire width of the wheel at an even volume and pressure. It is claimed that when a multi-blade fan of the type shown in Fig. 3 is in operation, the air rushes in almost at right angles against the opposite or "drive" side of the fan and its course is then abruptly changed nearly 90 degrees (as indicated by the arrows), which results in a loss of power and velocity. It is this loss that the conoidal fan was designed to overcome by increasing the width of the blade from front to back. The increased width of the blade at the drive side handles the excess amount of air, which is gradually deflected by the hub so that it describes an easy curve towards the periphery, as indicated in Fig. 2. The blades are also curved, the radius of the curve increasing toward the rear, thus forming a conical surface. This curve is so proportioned that the air is scooped up with the least impact, and




Figs. 2 and 3. Diagram showing Approximate Movement of Air when passing through Conoidal and Parallel Blade Fans

the radius of the curve is in exact proportion to the diameter of the inlet.

The increased width of the blades at the rear gives exceptional strength to the wheel, so that high speeds and loads can be maintained without difficulty. These blades are securely riveted in front to a conical flange and at the back to an extra heavy plate. The fan wheel has long babbitted bearings equipped with oil chains in the center and it is balanced by a special method to eliminate all vibration. The housing is involute in shape and built of rolled steel plate, well riveted and strongly reinforced by vertical and horizontal angle irons.

## WHITNEY SILENT CHAIN

The Whitney Mfg. Co., Hartford, Conn., is making a chain of the silent type which is so constructed that the sprocket wheels used in connection with it need not be flanged nor grooved, thus gaining the entire width for wear. This is accomplished by means of guide plates, which form an integral part of the chain, as shown in Figs. 1 and 2 in the ac-

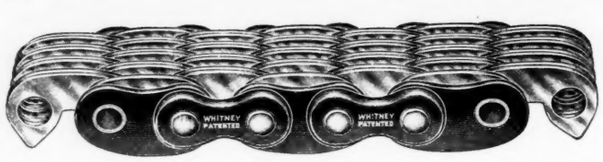



Fig. 1. Whitney Silent Chain

companying engravings. The guide plates *A*, Fig. 2, are connected by outside plates *B*, which give additional tensile strength to the chain. The links are so assembled that each joint has four wearing surfaces, making a very durable construction. Hardened steel bushings *C* are forced tightly into the guide plates, so that they are held fast and cannot turn. The steel links turn about the outside of the hardened steel

bushings, and the hardened steel rivets, which are also forced into the outside steel plates, turn within the bushings. These chains are made in various sizes, having ⅜-, ½-, ⅝-, ¾- and 1-inch pitch and also in various widths to suit requirements.

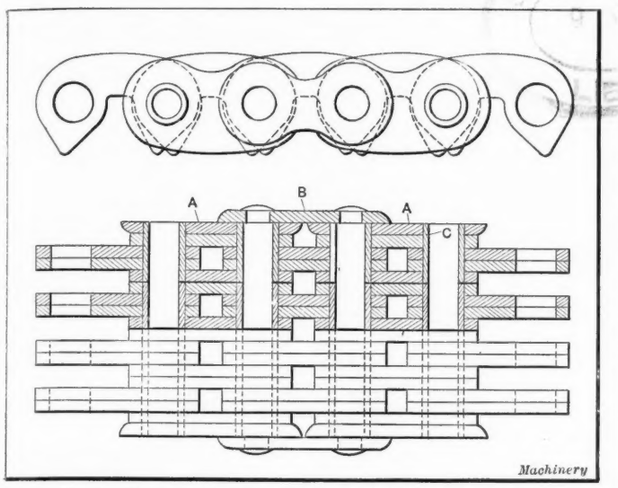



Fig. 2. Views showing Construction of Whitney Silent Chain

They are used for driving magnetos and cam-shafts on gasoline engines, machine tools, line shafting, pumps, and also in connection with automobile transmissions, motor drives, etc.

## AMERICAN TOOL WORKS 24-INCH HIGH-DUTY LATHE

The lathe illustrated in Fig. 1 is a 24-inch size of the "high-duty" type built by the American Tool Works Co., Cincinnati, O. The most prominent features claimed for this design are the great driving power and the high grade of workmanship. The arrangement of the geared head is shown by the diagram, Fig. 2. This head gives eight spindle speeds through a medium of twelve gears, two frictions and one jaw clutch. The speeds vary in geometrical progression and range from 7.3 to 270 revolutions per minute. The gears are of wide face and the pitch of the teeth is as coarse as practicable. These gears are mounted on short shafts which are rigidly supported to eliminate all vibration. The frictions have a large area of frictional contact which, in combination with their location on the initial driving shaft having a constant but high rate of speed, insures an ample transmission of power without slippage.

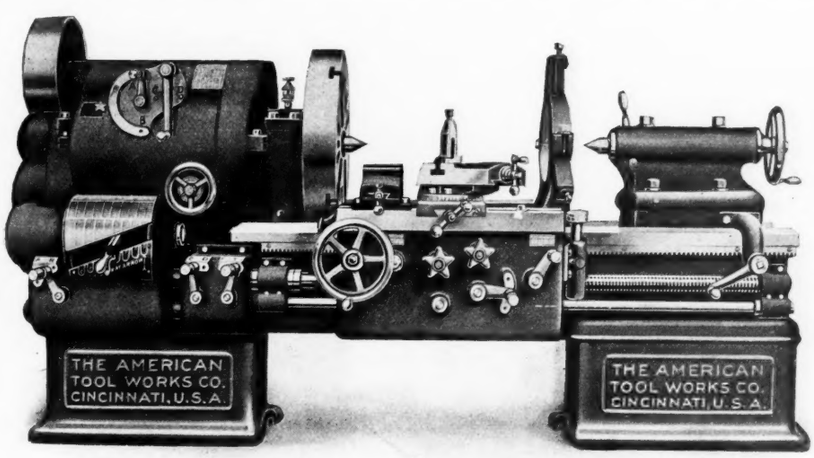



Fig. 1. American 24-inch Lathe with Geared Head

The spindle bearings have sight feed oilers and the other bearings are bronzed bushed, the bushings having recesses for retaining the oil. The oil is supplied through pipes from the outside of the head, and it is fed to the bearings by means of felt strips inserted in slots cut in the bushings. These felt strips filter the oil and distribute it uniformly over the bearings. They also prevent the lubricant from running out of the bearings and being wasted. The driving pulley runs on a bronze-bushed steel sleeve which relieves the initial driving shaft of all belt strain.

The thread-cutting and feeding mechanism is of the cone-and-tumbler type, and by means of seventeen gears and three control levers, gives forty-eight changes for threading or feeding. The cone-and-tumbler gears are cut with Brown & Sharpe 20-degree involute cutters, thus producing teeth which are pointed at the top and therefore easily engaged. The power can be transmitted direct through the cone for cutting coarse threads, thus eliminating the necessity of speeding up this mechanism by compound gearing. A quadrant construction at the end of the bed gives the lathe an almost unlimited range for feeding and screw-cutting. Any thread or feed not listed on the index plate can be obtained by placing gears of the proper size on the quadrant. The index plate, showing the different combinations for obtaining the various threads and feeds, is located directly over the tumbler lever and is direct-reading.

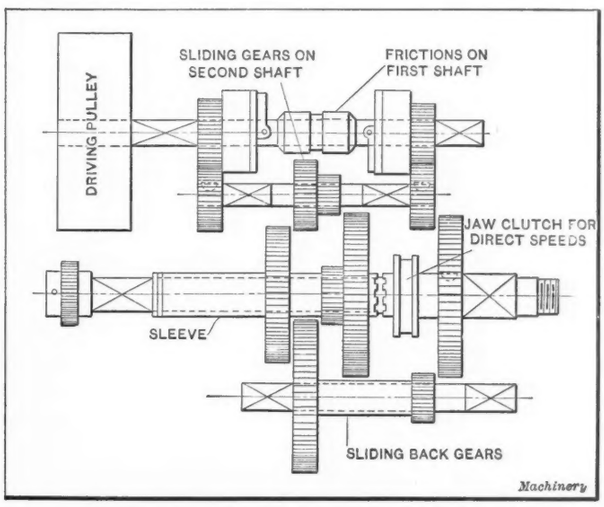


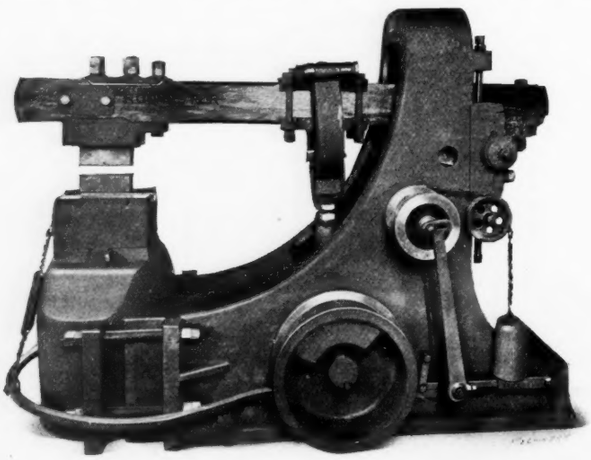

Fig. 2. Diagram showing Arrangement of Geared Head

The apron is of the double-plate type. All gears in the apron are of steel and the studs are hardened and ground. A non-interfering plate prevents the lead-screw and feed-rod from being engaged simultaneously. Oil for the apron is introduced from the outside through pipes which lead to reservoirs formed in the back plate. The oil is then fed to the different bearings by means of oil ducts and it is filtered and the flow regulated by strips of felt placed over the duct openings. The tailstock is the four-bolt type, the back bolts extending to the top of the barrel, which arrangement is very convenient for clamping. The tailstock is further supported by a pawl which engages a rack in the center of the bed. The barrel of the tailstock is solid and is equipped with an improved form of plug binder for clamping the spindle.

The power of this 24-inch geared head machine is indicated by the following data obtained from a recent test: A cut ¼ inch deep was taken across a bar of 6-inch machinery steel with a cutting speed of 150 feet per minute and a feed of ⅛ inch per revolution. This work was done with a single tool which removed 55.8 cubic inches of metal per minute, or 837 pounds per hour. This machine is also built with the cone pulley type of headstock or it can be furnished with a motor drive. The regular equipment includes a steadyrest, follow- and full-swing rests, thread dial, countershaft, wrenches, etc.

## ROCHESTER HELVE HAMMER

The "manufacturers' type" of helve hammer shown herewith is built in 60-, 80- and 100-pound sizes. The hammer illustrated is a 100-pound size and weighs 4000 pounds. The frame is a solid casting having solid babbitted shaft-boxes of large dimensions. The anvil is separated from the frame by wood segments which absorb the shocks from the blows and prevent them from being transmitted to the frame. The anvil is made in two parts which are keyed together, thus allowing for adjustment or the removal of the top part if

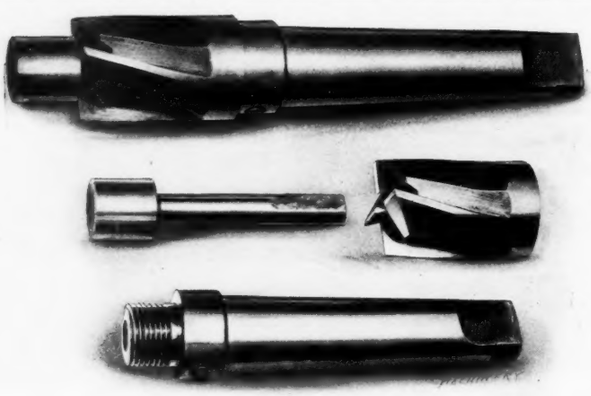


Rochester 100-pound Helve Hammer

necessary. The weight of the anvil is sufficient to give the proper resistance to the blow, which is an important feature. The boxes which support the helve-pivot at the rear end of the helve, have an adjustment of 5 inches, which is effected by the screws shown. This adjustment, in connection with the adjustment of the connecting-rod, adapts the hammer to a wide range of work. The helve is made of first-grade hickory, and the U-shaped spring and connecting toggles are of such design that a fine cushion is obtained by a slight action of the spring, thus minimizing the tendency to crystallization. This hammer is built by the West Tire Setter Co., Rochester, N. Y.

## NATIONAL TOOL CO.'S COUNTERBORE

The National Tool Co., Cleveland, O., has recently put on the market a patented counterbore which consists of three parts, namely, the shank, cutter and pilot. The accompanying illustration shows the assembled counterbore and also

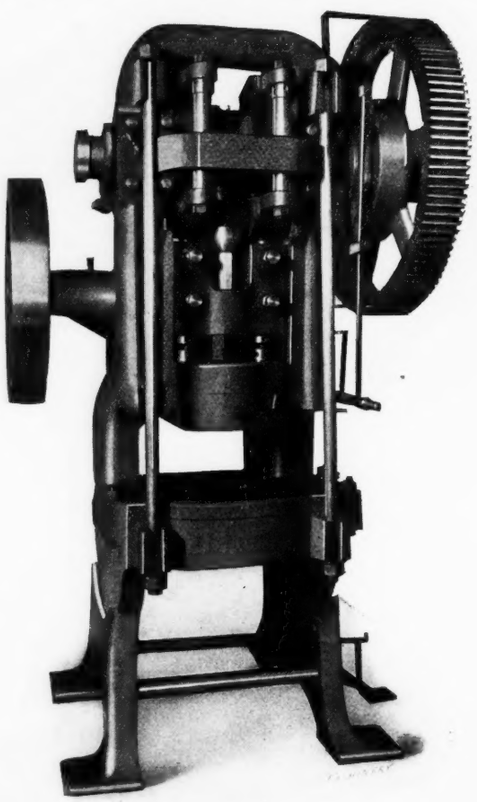


National Counterbore and its Component Parts

its component parts. The shank is made of machinery steel and the lower end is threaded for receiving the cutter. The cutters are made of high-speed steel. The hole for the pilot in both the cutter and shank is ground to insure a good fit for the pilot shank. The pilot is held by a set-screw which is inserted in the enlarged part of the shank as shown. The cutters have spiral flutes which give a shearing cut, and these flutes extend back so that the cutter can be used until two-thirds of its length has been ground away. This feature gives a long life to the cutter. Both cutters and pilots are interchangeable and are furnished with either taper, straight or double-groove shanks. All parts are made of the best material and are hardened and ground. The cutters and pilots carried in stock range in size from ¾ inch to 4 inches, advancing by sixteenths.

## STANDARD DOUBLE-ACTING CAM PRESS

The double-acting cam press shown herewith was designed for the deep drawing, at a single stroke, of light and medium gage metals, and also for producing the maximum draw, at one stroke, that stock of this nature will stand. It is particularly intended for drawing and forming stock having a maximum flow and a maximum ductility (such as mild aluminum, brass and copper) without broaching or breaking. This machine is built by the Standard Machinery Co., Providence, R. I. It is equipped with an extra-heavy drop-forged crankshaft, having tool-steel cams forced over the wings of the shaft, which are on each side of the upper connection of the inner or draw-



Standard Double-acting Cam Press

ing ram. The diameter of the wrist pin on the drawing ram is 3½ inches and the bore of the cams, 7⅛ inches. The overall length of the cams is 4⅜ inches, and they have a bearing surface of 3 inches. The throw of the blanking ram is 3 inches, which is unusually large for a cam press, but is provided to allow the production, at a single stroke, of a piece over three inches high without a raising die.

The drawing stroke or the stroke of the inner plunger is 7 inches, and the machine is so arranged that the blanking and drawing rams leave on the up-stroke at the same time, the movement being controlled by the setting of the cams on the crankshaft. The machine is fitted with capped boxes making it unnecessary to remove the shaft endwise. The yokes are of steel and the two lower ones extend through bronze-bushed holes in the blanking ram. The adjustment of this ram is controlled by the spanner nuts shown. The holes in the supporting strips at the back and front of the press, through which the yoke pins pass, are babbitted to secure good bearing surfaces. The inner plunger is of forged steel and runs up and down in the blanking plunger through a bronze sleeve.

The construction of both the blanking and drawing plungers, as well as the yokes and cams, is such as to give simple and easy adjustments and good wearing qualities. There is a single train of cut driving gears, and the company's regular instantaneous roller friction clutch is used. The machine is furnished either with a balance wheel or tight-and-loose pulley drive and can be used inclined. Either a hand or foot trip can be provided, and the machine can be equipped with a roll or dial feed for the production of special work.

## NEWTON COLD-SAW CUTTING-OFF MACHINE

The cold-saw cutting-off machine shown in Figs. 1 and 2 has a 40-inch blade and a capacity for round stock up to and including 12 inches in diameter, and for square material of the same dimensions. This machine is built by the Newton Machine Tool Works, Inc., Philadelphia, Pa., and it is designed for high duty. The spindle is of large diameter and its length is equal to the diameter of the blade. It revolves in bronze-bushed cap bearings located at both ends, and the driving spur gear is placed between the bearings to eliminate chatter and to prevent interference from chips or lubricant. The driving pinion meshing with this spindle gear is cut from the solid worm-wheel shaft. The worm-wheel is a solid bronze casting and the driving worm is of hardened steel and fitted with roller thrust bearings. The saw blade is driven by three round keys or pins and it is held in place by a large washer to prevent buckling.

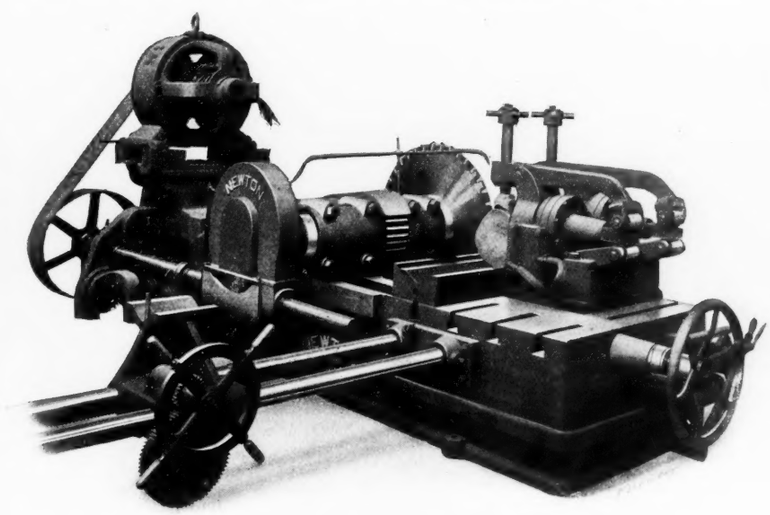



Fig. 1. Newton Cold-saw Cutting-off Machine with Pneumatic Clamps

The saddle has square bearings on the base and underlocking gibs. The bearing extends the full length and width of the shears. There are six changes of geared feed, a reversing fast power traverse and a hand adjustment. The feed-screw has a bearing at each end to always maintain a tension and it is located centrally between the saddle guides. The feed-nut is placed in advance of the spindle to draw the blade to the cut, thus preventing backlash and a rocking of the saddle on the base.

This machine is driven by a Westinghouse 30-horsepower motor which is mounted rather high to obtain a long belt drive.

The locations of the various operating levers are shown in Fig. 2. Hand-wheel *A* is for the hand feed, and levers *B* at each end of the machine engage and disengage the feed and fast power traverse. This machine is equipped with pneumatic clamps controlled by lever *C*, and there is a stock feed trolley which is clearly shown to the left in Fig. 1. The operator, after adjusting the stock trolley, turns the hand-screws *E* until the serrated V-blocks on their lower end touch the stock, after which the clamping is effected by simply turning air valve *C*.

It is claimed that as a result of the rapid clamping facilities and the convenient control, the blade is actually cutting about 90 per cent of the time. This machine is said to cut 10-inch round stock having a 35 to 40 point carbon content in about 4½ minutes, while during tests much greater speeds and feeds are possible. The average production of this machine since its installation has been twenty-three pieces of 7¼-inch round stock in one hour and fifty-six minutes, which includes the time for setting and removing the work.

## CINCINNATI PORTABLE REAMING AND DRILLING MACHINE

The electrically driven portable reaming and drilling machine shown herewith is an improved design made by the Cincinnati Electrical Tool Co., 650 Evans St., Cincinnati, O. This tool weighs only 27 pounds, but has a capacity for reaming holes as large as ½ inch in diameter and for drilling in steel up to ¾ inch in diameter. The motor is series wound and its armature is mounted on ball bearings. The gears, which are fully enclosed, are hardened and run in grease. The controlling switch is operated by a sliding sleeve on the

Cincinnati Reaming and Drilling Machine

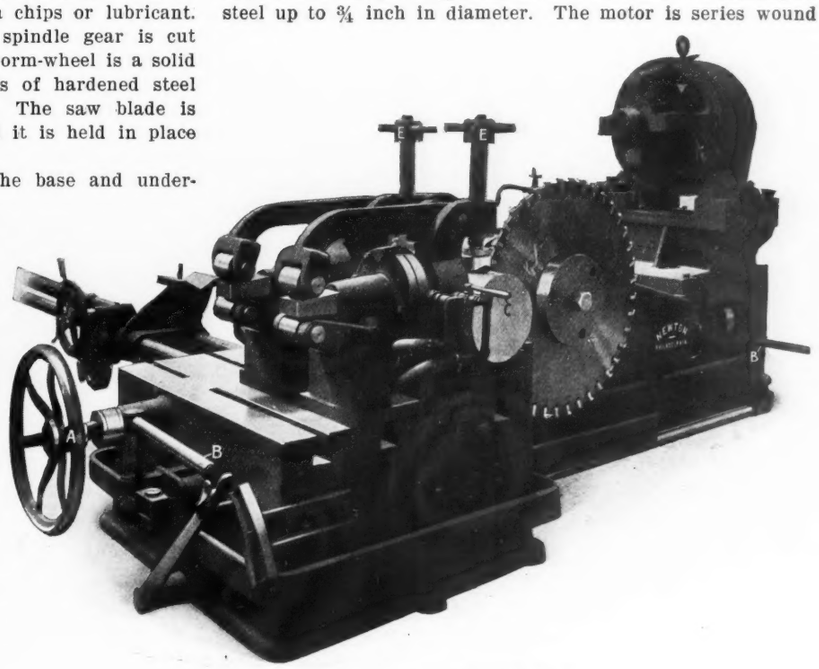



Fig. 2. Another View of the Newton Machine

handle. The spindle can be fitted with a chuck or be bored to receive a No. 1 Morse taper socket, the latter being recommended. Ten feet of insulated wire and an attachment plug are included in the equipment.

## HENRY & WRIGHT MULTIPLE SPINDLE DRILLING MACHINES

A recent addition to the line of drilling machines built by the Henry & Wright Mfg. Co., Hartford, Conn., is illustrated in Fig. 1. This machine, which is known as the "class B", has incorporated in its design a number of interesting improvements.

The tension of the driving belts is controlled from the front by means of handwheels located near the spindle driving pulleys. The spindle pulleys are supported at the top and bottom, instead of at the bottom only, and the spindles are driven by a new balanced drive, which consists of two hardened steel rollers set in a diametrically opposite, vertical position. These rollers are loosely fitted half-way into grooves in the spindle, so that they bear at the nearest possible point at the outside of the spindle and not only furnish an almost frictionless drive, but also a very powerful drive. This drive is located underneath the spindle pulley instead of on top, as formerly, which allows the use of a much shorter spindle and reduces the tendency of vibration when the spindle is raised to its highest point. The spindle is also much stiffer for a given length of traverse.

The spindle arms are of a new design and they are equipped with a new clamping device which is very simple and strong in its construction. The clamping levers for the arms are located on the left side instead of the right, as formerly, so that the workman can use both hands to the best advantage when raising and lowering the arm. The height of the drilling heads has been increased considerably and the base lowered an amount corresponding to this increase, in order to produce a stiffer and more convenient design. This machine is made either with a handwheel for raising and lowering the table or, when specially ordered, with a crank as shown in the illustration. The rear shaft pulley is fitted with a spring-locking device which enables it to be adjusted, when changing speeds, without the use of a wrench, from the front of the machine. There is an entirely new belt-shifting device which allows the belt shifter proper to be set at any angle. The base of the machine has an oil groove, and either a plain table or one having an oil groove can be supplied. The stop on this machine is applied to the rack instead of at the top of the spindle, as formerly.

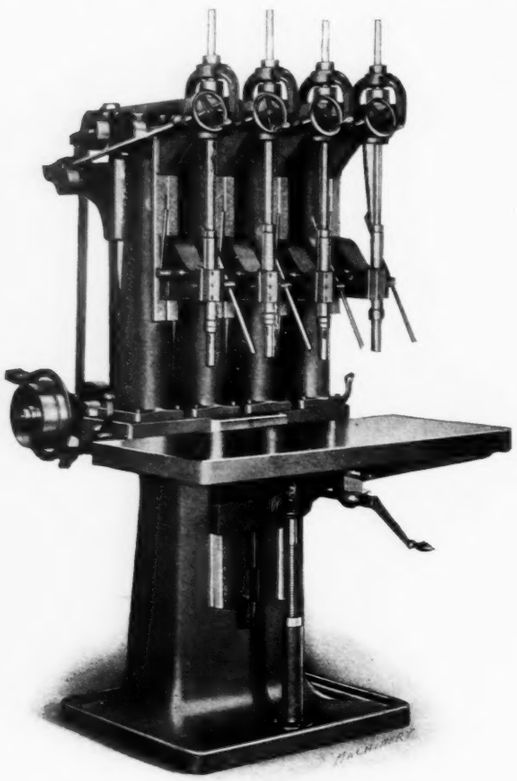


Fig. 1. Henry & Wright Drilling Machine

The machine shown in Fig. 2 is similar to the "class B" design with the exception of the base and table. As the illustration shows, the base is of the cabinet type. This machine is designed to be used where extreme stiffness and accuracy are desired. The table is attached to the base by four screws so that it can easily be removed for re-planing, if necessary.

Fig. 2. Henry & Wright Drilling Machine with Cabinet Base

Both of these machines are furnished with lubricating equipment, when so ordered, and in case of the cabinet base design, the oil tank is located inside the base and is connected with the table by four oil ducts leading from the centers of the four sides of the table.

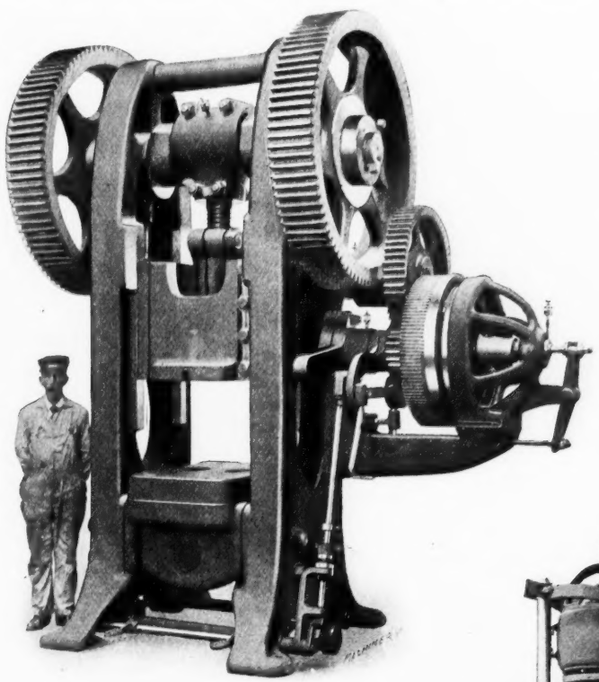
## FERRACUTE PRESS WITH IMPROVED FRICTION CLUTCH

The Ferracute Machine Co., of Bridgeton, N. J., has recently built a press designed for pressures up to 200 tons and fitted with a new form of friction clutch. The clutch mechanism is mounted on a bracket attached to the side of the press (as shown in the accompanying illustration) instead of using an independent outboard bearing. With this construction the position of the press can be changed at any time, without re-setting and re-aligning the clutch. As this clutch and its bracket form a complete unit, it can be attached to various machines without altering the design, by simply bolting it in place.

The brake spider has been made a part of the clutch supporting bracket, which is new feature. This brake spider is a separate piece, but the face or seat to which it is bolted is cylindrical and the axis of this cylindrical surface coincides with the axis of the clutch shaft, so that perfect alignment is secured. Another improvement is the motion which relieves the clutch and does the braking direct without introducing additional mechanism. This effect is produced by the clutch disk which is a horizontally moving, double cone located be-

tween the brake spider and the flywheel. Attached to the front and back rims of the clutch disk are wooden sectors or blocks the outer faces of which bear against corresponding surfaces on the inside rim of the flywheel and clutch spider. These blocks are adjustable radially by means of screws which are secured by lock-nuts. The blocks are attached to the clutch disk by carriage-bolts. The movement of the clutch disk in one direction or the other produces the clutch or braking action as desired, the clutch disk having both the clutch and brake frictional surfaces.

The clutch shaft is journalled in two boxes. Gear teeth are cut in an enlarged portion of the shaft, producing a pinion which engages with the intermediate gear, as shown. The flywheel revolves freely on the clutch shaft and the outer end of the latter is bored axially. A cylindrical rod or plunger moves horizontally in this bored hole and the inner end of this rod is connected by toggles to the clutch disk, which is given the small amount of motion and heavy pressure required. The clutch may be engaged by a foot-treadle or by the hand-lever shown at the side of the press. The action



Two-hundred Ton Ferracute Press

can also be automatic if desired. Accessibility to the parts requiring adjustment has received careful attention.

Some of the principal dimensions of this press are as follows: Stroke of the ram, 10 inches; adjustment of the ram, 6 inches; distance from the bed to the ram with the latter at the top of its stroke and adjustment, 30 inches; distance between the columns, 32 inches; thickness of bolster, 5 inches; extreme height, 127 inches, and total weight, 38,000 pounds.

## RADIAL DRILLING AND REAMING MACHINE

The wall type of radial drilling and reaming machine shown herewith is one of a number furnished to the McClintic-Marshall Construction Co. (contractors for the steel work on the Panama Canal Locks), by the William E. Gang Co., Cincinnati, O. These machines are used principally for drilling and reaming, and when in use they are attached in gangs to the columns or legs of a movable steel structure similar to a gantry crane.

The drill spindle and its driving motor is mounted on a double-hinged arm consisting of two 4-foot sections. The maximum distance from the center of the spindle travel to the face of the wall-plate, is 8 feet 7 inches, and the arm has a vertical travel on the wall-plate of 3 feet 5 inches. Fig. 2 shows the elevating mechanism in detail. A 2½-inch elevating screw *E* is supported on a roller thrust bearing *B* in a

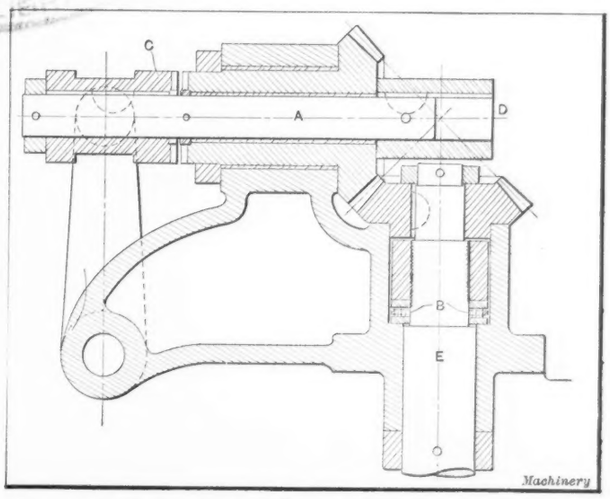



Fig. 2. Elevating Mechanism of Radial Drilling Machine

bracket that can be set on either side of the wall-plate. The elevating screw is connected by miter gears and a sliding clutch *C* with the power shaft *A*. In this case, the elevating mechanism for a group of machines is driven by one motor, connection being made at *D*. The lever shown hanging from the elevating gear bracket (see Fig. 1) controls the vertical movement of the arm, and the slotted bar shown is an adjustable stop for limiting the travel. The elevating lever can be locked in a neutral position.

A pull of less than ten pounds is sufficient to move the arm to any position, due to its being provided at the hinges or trunnions with roller bearings and ball thrust bearings. The rollers run between inner and outer steel sleeves, and in case

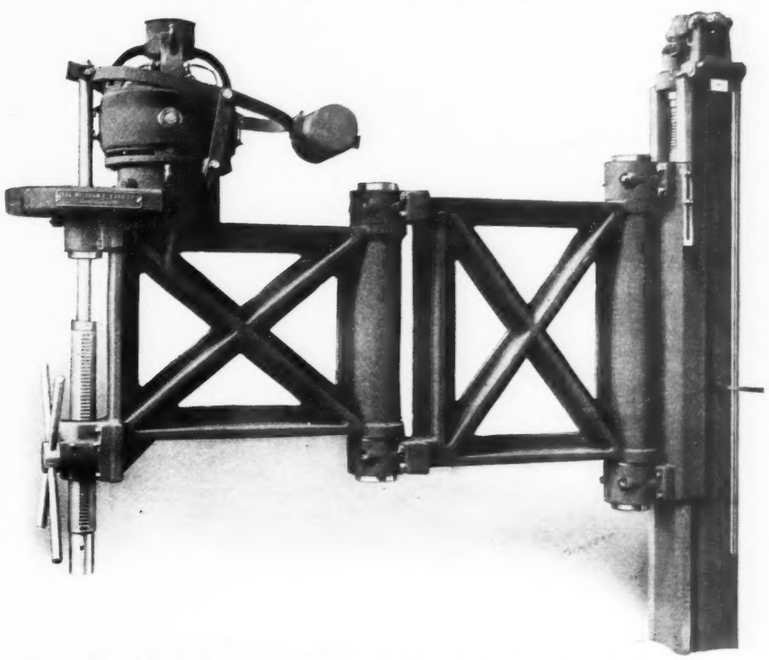


Fig. 1. Special Radial Drilling and Reaming Machine built by the William E. Gang Co.

looseness should develop through wear, these sleeves can be easily replaced without affecting the steel trunnions. The trunnion journals are capped to facilitate taking them apart, and to insure accurate alignment they are tongued and grooved and taper dowel pinned. Provision is made for excluding the dust and dirt from the ball and roller bearings.

The driving motor for the spindle, which is mounted near

the outer end of the forward gate or arm, is geared directly to the spindle by steel gearing. It is a Crocker-Wheeler, variable speed type of 3¼ horsepower capacity. The spindle is made of high-carbon crucible steel, and it runs in a bronze-bushed steel quill or sleeve. The vertical traverse of the spindle is 26 inches, and it is moved up or down by a steel rack and pinion and the pilot wheel shown. The pilot wheel levers are screwed into a steel pinion head and they are pinned in position to prevent their working loose. The method of counterbalancing the spindle is clearly shown by the illustration. This machine is massive and of high-grade construction. Its net weight, including the motor, is 7000 pounds.

## CINCINNATI GEAR TURNING LATHE

The Cincinnati Pulley Machinery Co., Cincinnati, O., is now manufacturing a 32-inch gear turning lathe. This machine, front and rear views of which are shown in Figs. 1 and 2, is specially designed for finishing steel gear blanks. It is, of course, also adapted to cast-iron work at increased speeds and feeds.

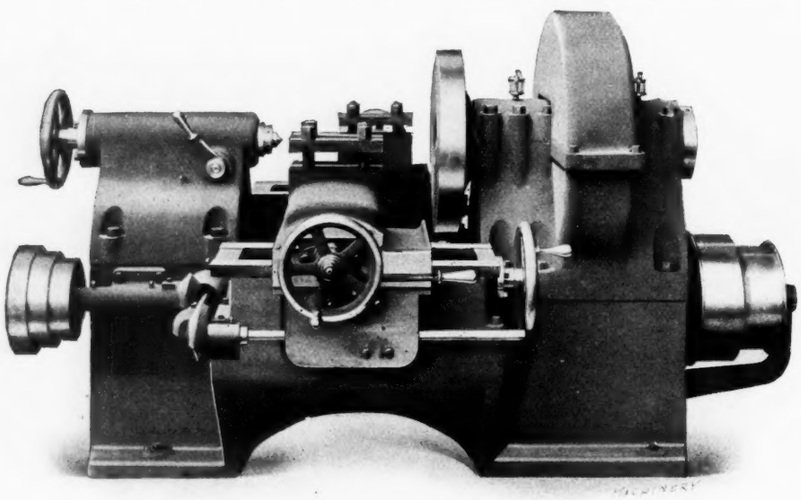


Fig. 1. Special Gear Turning Lathe built by Cincinnati Pulley Machinery Co.

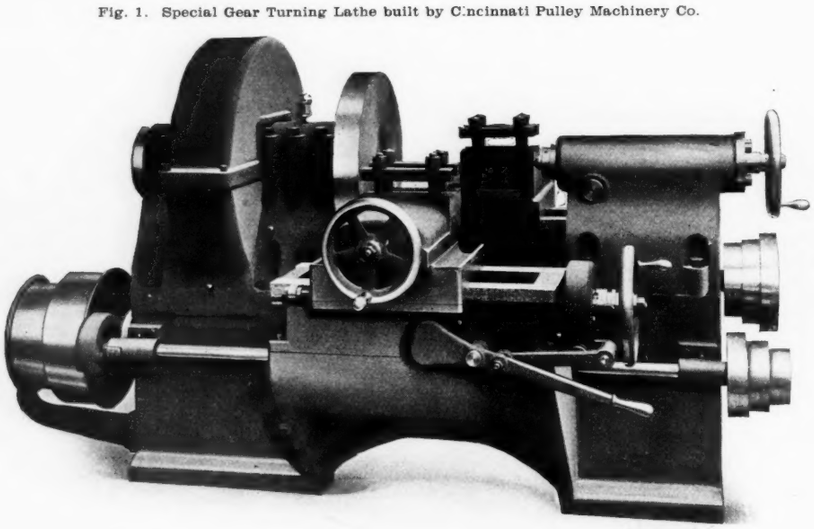


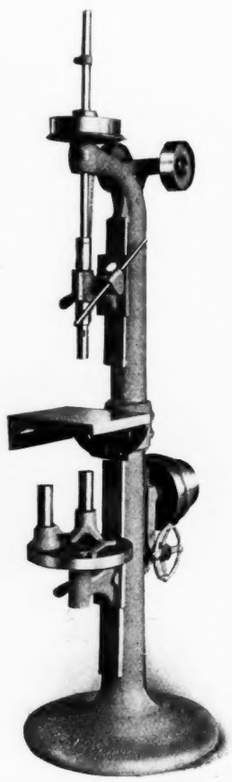
Fig. 2. Another View of Gear Turning Lathe

There are two tool slides, one being at the front and the other at the rear. These slides are mounted on rails which are bolted to extensions on each side of the bed, and they have independent movements. One slide is provided with a power longitudinal feed and the other has a power cross-feed. In addition, both slides have cross and longitudinal hand adjustments.

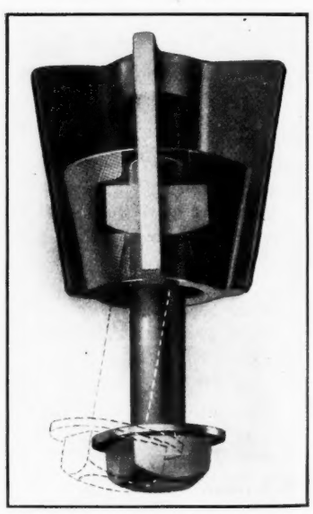
The machine is driven by a belt operating on the two-step cone pulley seen to the right in Fig. 1. This pulley connects with the spindle through large spur gearing, having a ratio of 26 to 1. The spindle has four speeds ranging from 9 to 16.5 revolutions per minute, which are obtained by a two-speed countershaft and the two-step cone pulley. The main spindle gear, which is of steel, has a 4-inch face and is 4 pitch. The spindle, which is 7 inches in diameter, is made of hardened crucible steel and is bored its entire length.

The feeding movement is derived from the cone pulley shaft through spur gearing, which drives the feed-shaft as shown in Fig. 2. This feed-shaft actuates the longitudinal slide above it and the feed is engaged or disengaged by the clutch lever and clutch shown to the right. Connection to the opposite side of the machine is made by a belt operating on the three-step cone pulleys shown. Fig. 1 clearly indicates the feed transmission for the slide having the power cross-feed.

This machine is heavily built and of very rigid construction, as the illustrations show, and it is adapted to the heaviest cuts which high-speed steel tools are capable of taking. All pinions and feed gears are of steel and are entirely encased. The machine has a 32-inch swing and a capacity for widths up to 18 inches. There are three longitudinal feed changes, varying from 1/32 to 1/16 inch and a similar number of cross-feed changes, varying from 0.018 to 0.036 inch. The weight of the machine is 6500 pounds.



Washburn 15-inch Drilling Machine



Bolt Anchor for Concrete Construction

## WASHBURN DRILLING MACHINE

The Washburn Shops of the Worcester Polytechnic Institute, Worcester, Mass., are now manufacturing a 15-inch drilling machine, the general construction of which is shown by the accompanying illustration. This machine has ball bearings throughout and it is designed to take high-speed drills up to and including ¾ inch in diameter. The drive is from the back cone to the spindle pulley by a quarter-turn belt running over idler pulleys in the usual manner. The construction of the spindle pulley is such that the belt tension is carried by an independent bearing, thereby relieving the spindle so that it runs absolutely free. This bearing is surrounded by a concentric ring which retains the oil and prevents it from spattering. The belt tension is controlled by an automatically locked belt tightener. The arrangement of this device is such that the cone is locked in any position in which it may be left, and the belt tension can be changed by simply turning the handwheel shown. The machine is equipped with both square and round tables. The square table may be tilted and it is mounted on a bracket which revolves about the column, thus permitting it to be swung out of the way when the round table is used. The size of the square table is 12 inches and the apron at the side is 4 inches wide. The round table is 12 inches in diameter and it is adjustable on the column. It may also be removed and either a cup or crotch center substituted. Both of these centers are included in the equipment. The net weight of the machine, with countershaft, is 625 pounds. The countershaft is fitted with ring oiling bearings and the loose pulley runs on a loose bronze bushing.

## HILL BOLT ANCHOR FOR CONCRETE WORK

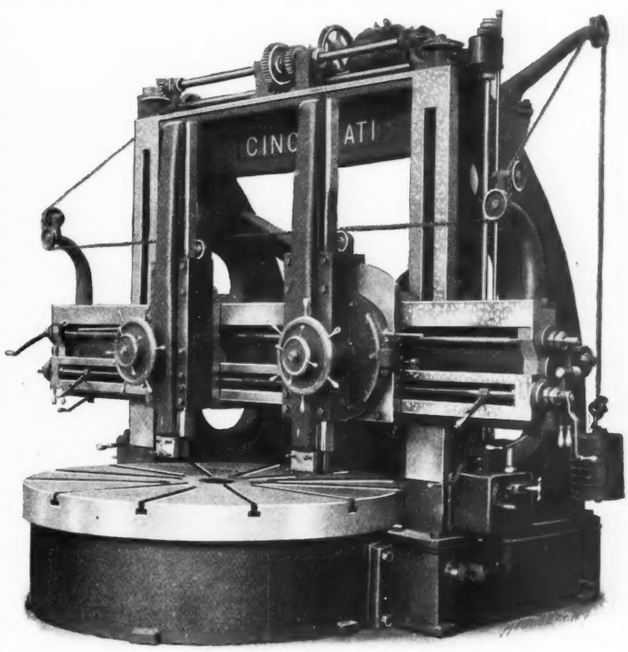
A bolt anchor for use in connection with concrete construction is illustrated herewith. This anchor was primarily designed for supporting shaft hangers, but it is adapted to various other classes of concrete work. The anchor body is conical and it has wedge-shaped longitudinal wings or ribs. This form of anchor is strong but light, and it has great holding power. The conical wedge shape resists tensional strains and the wings prevent the anchor from turning. The nut is inserted within the casting as shown. It has a chamfered face resting on a seat and is free to oscillate, but is prevented from turning by abutments. With this arrangement, the bolt can readily be entered in the nut even though inserted at an angle, thus allowing for considerable irregularity in setting the anchor. These anchors are made for bolts of the following sizes: 1½ inch by 3 inches, ⅝ inch by 4 inches, ¾ inch by 4½ inches, ⅞ inch by 5 inches, and 1 inch by 6 inches. They are the product of the Hill Clutch Co., Cleveland, O.

## CINCINNATI BORING MILL

The boring mill illustrated in the accompanying view is an 8-foot size built by the Cincinnati Planer Co., Cincinnati, O. This machine is similar in its construction to the 10-foot size Illustrated in the department of New Machinery and Tools for February, 1911.

The entire mechanism of the mill is supported on the bed, so that only one foundation is required and alignment of all parts is assured. The table is supported on a broad flat annular bearing of large diameter, which is automatically lubricated by rollers. The oil pockets are filled and drained from the outside. The table diameter equals the full capacity of the mill. The center spindle revolves in a bushed adjustable bearing and there is a step bearing at the lower end which can be adjusted to take more or less load, as desired. The table can also be raised sufficiently for high speeds. The main internal driving gear is cut from the solid, and the pinion is made from a solid steel forging.

The housings have, in addition to the usual brace, an X-brace at the rear to take any side or twisting strains due to heavy cuts when the cross-rail is elevated considerably above the table. The cross-rail has a deep arch at the rear to eliminate deflection, and it is secured to the uprights by clamps engaging both the inner and outer sides of the housings. The heads have a narrow guide bearing at the bottom of the rail to prevent tilting or binding, thus relieving the feed mechanism and insuring permanent alignment. Both heads have a rapid power traverse in addition to the hand adjustment. The handles have a safety lock so that they cannot revolve when the rapid traverse is used. Ratchets are provided on the rail screw for making fine adjustments. These can be moved to suit the convenience of the operator. The cast-steel tool bars also have the rapid power traverse in both directions. Eight feed variations are provided, ranging from 1/32 to 1 inch. These changes are effected by levers on the




Cincinnati Eight-foot Boring Mill

feed-box at the side of the housing. A separate feed-box is attached to each housing, so that the heads have independent feeding movements.

Either a belt or motor drive is supplied. For a belted drive, a four-step cone pulley is mounted on top of the speed box giving sixteen variations, and the drive for raising and lowering the rail is taken direct from the countershaft. For a motor drive, a 2 to 1 variable-speed motor is used in connection with a speed-box giving four mechanical changes. This motor can be belted to the speed-box or connected direct by gearing. A small additional motor is required for raising and lowering the cross-rail.

## NEW MACHINERY AND TOOLS NOTES

**Tap Wrench:** Alert Tool Co., 4731 N. Mascher St., Philadelphia, Pa. Ratchet tap wrench which can be made either right- or left-hand at the will of the operator. These wrenches are made in sizes varying from ⅛ to ¾ inch.

**Screw-driver:** H. D. Smith & Co., Plantsville, Conn. Screw-driver with handle divided longitudinally through the center and so arranged that one or both halves can be set at right angles to obtain a leverage, when inserting a large screw.

**Electric Grinder:** Hamilton-Beach Mfg. Co., Racine, Wis. Aluminum mounted electric grinder, which weighs only five pounds and is adapted for either external or internal work. A one-tenth horsepower motor is used which operates on direct or alternating current.

**Compound Rest:** Stark Tool Co., Waltham, Mass. Improved compound slide rest for bench lathes. The tool-post will hold either round or square turning and boring tools. The boring tools are held in an eccentric quill giving an adjustment for setting the tool central.

**Cylinder Boring Machine:** Moline Tool Co., Moline, Ill. Single spindle cylinder boring machine for single or twin cylinders. It has a compound table so that two or more cylinders may be bored at one setting. The feed is by double steel rack and pinions. The table is counterbalanced and has an automatic stop and quick return by a pilot-wheel.

**Toolholder:** B. Morgan, Newport, R. I. Toolholder consisting of two hardened steel parts between which the tools are clamped. The upper and lower members are kept in line

by a connecting link which has an elongated slot that allows the respective positions of the parts to be reversed. One side of each member has a V-groove, and either round, square, hexagon or other shaped tools can be held.

**Cold Saw:** Higley Machine Co., Croton Falls, N. Y. Cold sawing machine with capacity for I-beams or other material up to 20 inches wide and 7 inches high. The saw cuts from above so that it is easy to adjust the work by marks made on the upper surface. The table has a lateral movement of 3 inches, so that the work can be set approximately in line with the saw and then be accurately adjusted.

**Press Guard:** H. & A. Lock Co., 156 Fifty-third St., Brooklyn, N. Y. Automatic punch-press guard operated entirely by the regular pedal trip. The arrangement is such that the clutch is not engaged until the guard is raised. As the foot pedal is pressed, the guard swings upward until it is nearly vertical when the clutch acts and the press is tripped. It is impossible to trip the press when the guard is down.

**Drill Chuck:** Emrick Drill Co, 139 Stockholm St., Brooklyn, N. Y. Chuck in which the drill is gripped by three equally spaced cam-shaped jaws, which are geared together and controlled by a knurled outer sleeve. As the twisting strains on the drill increase, the grip automatically tightens. The drill can be instantly released while the machine is in motion by holding the knurled sleeve. The chuck is simple in construction and has few parts to get out of order.

**Patternmakers' Disk Grinder:** Gardner Machine Co., Beloit, Wis. Motor-driven patternmakers' disk grinder of the single end type carrying a 30-inch disk wheel. This wheel is driven from the motor shaft through spur gears, the pinion of which is of rawhide. The controller is attached to the front of the machine and the operator can start or stop the machine from the working position. A five-horsepower motor is used. This same style of drive is adapted to other kinds of disk grinders built by this company.

**Special Facing and Boring Machine:** Rochester Boring Machine Co., Rochester, N. Y. These machines are built for combined facing and boring or for facing only. There are two facing arms which can be operated simultaneously on surfaces in different planes. The arms are of different lengths and the longer one will face up to 50 inches in diameter. The feed for facing is of the well-known star wheel type. The starting, stopping and changing of speeds are controlled by a single conveniently located lever.

**Shaper Attachment:** L. E. Rhodes, Hartford, Conn. Horizontal shaper with attachment for vertical planing. The vertical attachment is applied by mounting it on the column after the regular ram is removed. It consists of a housing carrying the ram and a bellcrank driving mechanism which connects with the regular rocker arm of the shaper. The ram can be tilted from the vertical for machining angular work, and its stroke is changed in the usual way. The stroke may be varied from 0 to 3½ inches, and the maximum distance under the ram is 8½ inches.

**Hacksaw Machine:** L. H. Olmstead's Son, Hasbrouck Heights, N. J. Hacksaw machine of compact design, constructed to give a true vertical cut. The hacksaw frame is reciprocated by a revolving crank and connecting-rod, and the movement of the frame is the same irrespective of its height above the table. The work can be set to an angle, and its position is indicated by a pointer and graduations. The machine is started and stopped by a clutch attached to it. Three sizes are built having capacities for stock varying from 2 to 4½ inches square.

**Machinists' Tools:** Brown & Sharpe Mfg. Co., Providence, R. I. Improved machinists' tools consisting of pocket slide caliper rule adapted to internal and external measurements; a thread tool vernier for measuring thread tools when grinding for different pitches; an inside micrometer caliper with a capacity from ½ to 1½ inch; a micrometer head designed to be readily attached in any position for making fine adjustments; an improved universal bevel protractor with vernier reading to five minutes; and accurately made hardened and ground V-clamps made in pairs and designed for use when laying out work.

**Grinding Machine:** Norton Grinding Co., Worcester, Mass. Grinding machine especially designed for car axles. The machine is equipped with a hoist and a pneumatic arrangement to facilitate handling the work. The total weight is about 23,000 pounds and the weight of the grinding wheel head with its revolving parts is about 5000 pounds. The machine is motor-driven, one motor supplying power for all the parts. It is equipped with a pump which delivers about fifty gallons of water or lubricant per minute. The headstock and footstock are made heavy to absorb vibration and the headstock has a gear-box to provide the necessary speed changes. The work is started and stopped by a lever conveniently located near the center of the machine.

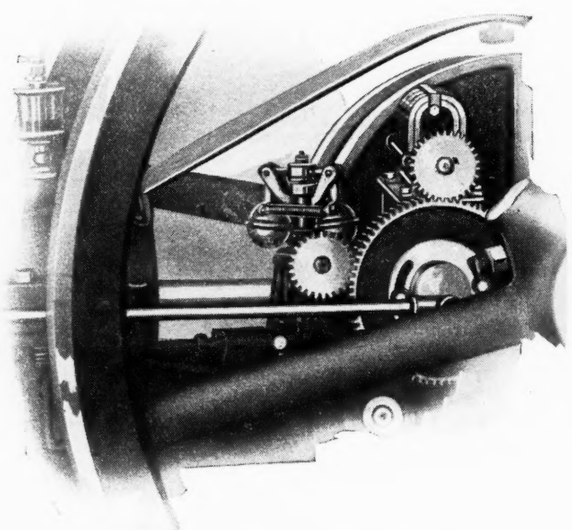
**Vacuum Cleaner:** B. F. Sturtevant Co., Hyde Park, Mass. Vacuum cleaner adapted to factory use and for general work. This is an electrically driven fan-type machine and maintains a strong steady suction free from pulsations. The suction is produced by a two-stage fan, directly connected to the motor. The fan is enclosed in a cast aluminum casing mounted on rubber-tired wheels so that the machine can easily be moved about, and it is equipped with ball bearings and is perfectly balanced to eliminate vibration. Oiling is not necessary as the bearings are packed in grease, which seldom needs replacing. The machine can be emptied and the dust bag replaced in less than a minute. All tools are aluminum, with the exception of the extension handles which are nickel-plated brass tubing.

**Vertical Shaper:** Pratt & Whitney Co., Hartford, Conn. Vertical shaper resembling in appearance a slotter and designed for the usual run of small slotter work and also for the class of work ordinarily done on the horizontal shaper. It is equipped with a rotary table and has cross and longitudinal movements similar to a slotter. The ram slide containing the ram can be set to an angle for taper planing and its position is shown by graduations. The ram is driven by a link mechanism similar to that used in the Pratt & Whitney horizontal shaper. The ram head and toolpost can be swiveled to any angle in a horizontal plane, so that the tool can be set in the best position. This shaper has a maximum stroke of 6½ inches and a maximum distance from the top of the table to the end of the ram of 13½ inches. The rotary table is 20 inches in diameter, the longitudinal travel 25 inches, and the cross movement 14 inches.

* * *

## GAS ENGINE WITH BUILT-IN MAGNETO

The Foos Gas Engine Co., Springfield, O., has abolished batteries on all its standard-type engines, and magnetos will be used hereafter. The magneto is a "built-in" design which forms an integral part of the engine. The method of driving it directly from the crankshaft, through gearing, is indicated by the illustration. This magneto gives a low voltage to permit using make-and-break igniters without deterioration of electrodes. The magneto's speed is comparatively slow, and it is constructed to give a high electrical efficiency, so that a spark can be generated for starting while turning the engine slowly by hand. The igniter electrodes are brought into frictional contact by the wiping action of a revolving



Foos Gas Engine Magneto and Direct Drive

blade, which is designed to keep the sparking surfaces clean and prevent fouling. The magnets used in this magneto are made from tungsten steel and consist of a set of six bars, 5/16 by 1 1/2 inch. The armature is laminated, being made of special soft sheet iron. The armature windings are of high-grade double-insulated wire. The collectors for the current bear on smooth polished surfaces. An alternating current is produced having two "peaks" for each revolution of the armature. The current generated during the rest of the revolution is too weak to produce a spark. The relative position of the two peaks is fixed and synchronized by setting the armature in proper relation to the engine. It is claimed that the reason that magnetos have not been used heretofore on stationary engines, is because the electrical efficiency has been too low to generate a hot spark at slow speeds.

* * *

Users of the advertising pages should note that the location of the page of foreign dealer advertisements has been changed from 12 to 224.

## A QUESTION IN SHAPER DESIGN—A REPLY

We have no intention of entering into any extended controversy with the writer of the article, "A Question in Shaper Design" published in the December issue of MACHINERY. In our opinion, this article would be of more value if the statements and criticisms came from an authority who had no self-interest to influence his judgment, and, as it might possibly be misleading to those who are not familiar with the Stockbridge shaper, we feel obliged to take exception to most of the statements made. We shall consider these statements as briefly as possible. In the first place, the article which appeared in the October number, was merely a study in kinematics and no one will question but that it was published

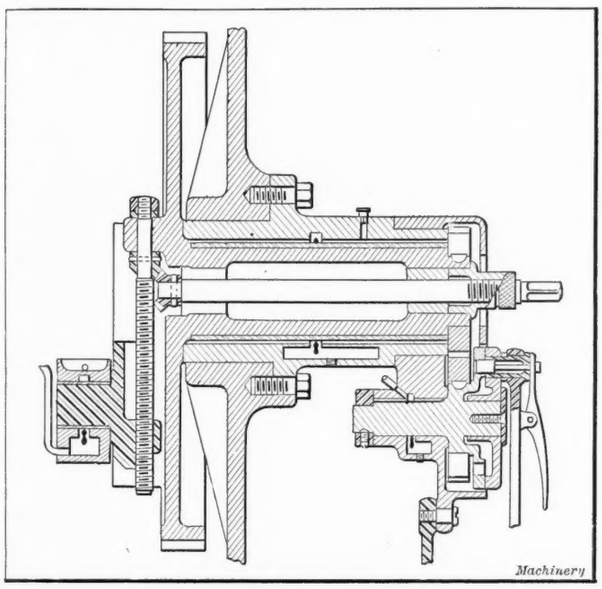



Fig. 1. Queen City Shaper Crank Mechanism

with no desire to prejudice. The sincerity and honesty of the article is beyond question. Therefore the first statement in the comment appearing in the December number, that the former article "does not properly set forth the merits of the plain slotted crank," we can dismiss as out of place. The following is another quotation of the article in question: "Fig. 1 shows the construction of our simple quick-return mechanism." The "simple quick return" referred to is a small increase of speed during the return stroke, due to the inclined position of the rocker-arm when the shaper is on its longest strokes. As the length of stroke is shortened, the return speed is reduced very rapidly as the rocker-arm approaches more nearly a vertical position. The quick return of a regular crank shaper when on a stroke less than one-half its full length stroke, is so small that for all practical purposes it may be neglected. A quick return is of the greatest value on its shorter strokes. The Stockbridge "two-piece crank" motion maintains this quick return even down to a 1-inch stroke. Why does our competitor lay so much emphasis on the quick return in his advertising and at the same time argue that a quick return is not desirable?

Attention is called to the fact that in the regular crank shaper there is only one bearing surface for the bull gear. Compare the unsupported gear, Fig. 1, with the construction shown in Fig. 2, and note that the gear in the latter illustration has a bearing on its periphery. With this construction all strain and, consequently, friction is taken off the crank hub and the hub is practically free from wear. The advantage of our construction over that of Fig. 1, with a small diameter hub as compared with the diameter of the gear is, in our opinion, too evident to need comment. The question of friction is one that can only be determined by tests. To us, however, this question of the number of bearings does not seem to be so important a factor in friction, as the question of rigidity of parts and the way in which they are supported against cramping. The friction of stiff, free-running parts is a small matter when compared to the friction and troubles due to too much overhang or to any other defect in design that allows spring or cramping. Our patented main bearing support for the bull gear (Fig. 2) eliminates all possibility of spring or cramping and we believe it to be the better construction.

The following table of tests was not made by us, but by H. P. Fairfield, of the Worcester Polytechnic Institute—a man whose authority and reputation gives it value. The difficulty of making any comparative test is to get all the conditions absolutely the same, and a comparison of tests made on

| Depth of Cut, Inch | Length of Cut, Inches | Feed per Cut, Inch | Cutting Speed, Feet per Minute | Horsepower, Stockbridge Two-piece Crank | Horsepower, Regular Crank |
|---|---|---|---|---|---|
| ⅜ | 12 | 0.0294 | 15 | 2.10 | 3.08 |
| ⅜ | 12 | 0.0294 | 17 | 2.68 | 3.35 |
| ⅜ | 12 | 0.0294 | 25 | 3.22 | 3 62 |
| ⅜ | 12 | 0.0294 | 30 | 4.02 | 4.16 |

different machines under different conditions is valueless. The comparisons mentioned in our competitor's article are for this very reason of no value—there is no basis of comparison. To make a fair comparison, every condition must be identically the same. Mr. Fairfield, in his tests, made use of the same machine, changing it into a regular crank shaper by simply bolting the crank and gear together, and thus eliminating all the parts which make up the "two-piece crank." In the first place, tests were made with the "two-piece crank," about twenty-five readings being made for each test, and an average taken; then the gear and the crank of this same shaper were bolted together, making a regular crank shaper. In other words, in the latter test, the friction of sliding blocks and the extra bearing surfaces of the "two-piece crank" shaper

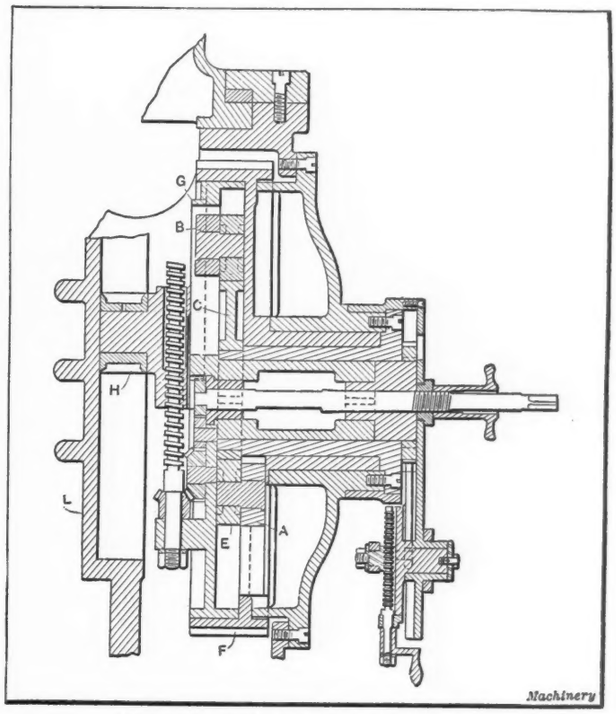



Fig. 2. Stockbridge Shaper Crank Mechanism

were eliminated. These tests were made on identically the same machine, the same material was worked upon, and the same cutting tool used, etc. The results of these tests are given in the accompanying table. The tests prove that any increase of friction because of the additional parts of a "two-piece crank" is more than offset by the gain of power.

The parts which are actually required to make up the "two-piece crank" are the eccentric *C* (Fig. 2), eccentric ring *E* with two blocks *A* and *B*, crank *G* and gear *F* which is used in both constructions. By referring to Fig. 2, it will be seen that the assembled parts are just as compact as a regular

crank. The extra parts used are not numerous or complex, as anyone can see, and we know the advantages obtained are altogether out of proportion to the disadvantage—which is the cost of manufacturing.

That the Stockbridge crank does produce the results claimed, our competitor freely admits; however, the motion does not seem to be fully understood by him, judging from further remarks in regard to the accelerated motion of the Powell planer. He draws the inference that if the accelerated motion of the Powell planer is an advantage, the even cutting speed which we get is not. A study of the velocity curve in the October issue will show that what we accomplish is practically what Mr. Powell accomplishes in his accelerated motion. The velocity starting at cipher increases gradually, but does not come up to full speed on the length of stroke shown, until it has traveled about 2 inches, and as ¾ inch is all that is required for tool clearance, it will be seen that the tool enters the work at a slow speed and then comes up to its maximum and maintains that speed until it almost reaches the end of the stroke. The speed then drops off gradually, thus accomplishing practically what the Powell motion does on a planer. The following quotation is also taken from the former article: "If the quick return is so important, why the variable speed planer with the constant return?" This comparison is misleading and hardly fair. In the construction of the planer, the thing that has been worrying designers is to get a number of forward or cutting speeds. The shaper already has the varying forward speeds. The constant return speed of the planer is the maximum speed at which the table can be returned. This is just what we are aiming at in our "two-piece crank" motion—to return the ram at the fastest possible speed at which it can be returned and as near a constant speed as possible. It makes no difference whether the stroke is 2 inches or 24 inches, the Stockbridge crank motion maintains more nearly than any other crank motion, a high, uniform return speed.

Our competitor states, "The real question at issue is how much work can be produced in a given time and at what expenditure of power?" Consider a 24-inch shaper on an 8-inch stroke, 40 strokes per minute. The regular crank shaper on this length of stroke would, practically speaking, have no quick return; with the Stockbridge crank, the return ratio would be a little over 2 to 1. Each complete revolution of gear would require 1½ second. The regular crank requires about ¾ second on the cutting stroke and nearly the same on the return stroke, for each revolution of the gear, whereas the Stockbridge crank requires 1 second on the cutting stroke and ½ second on the return stroke for each revolution of the gear. The rate of the regular crank tool movement over the work, per second, $=\frac{8}{1}\times\frac{4}{3}=\frac{32}{3}$; and the cutting speed $=\frac{32}{3}\times\frac{60}{12}=53\ 1/3$ feet per minute. The rate of the tool movement over the work is 8 inches per second with a Stockbridge crank, and the cutting speed $=\frac{8}{1}\times\frac{60}{12}=40$ feet per minute. If at a given cut and feed, the tool will stand 53 1/3 feet per minute on an 8-inch stroke, with the regular crank shaper, one of three gains can be made with the Stockbridge shaper on the basis of the foregoing figures. First, the length of the stroke can be increased to 10 2/3 inches and still maintain the same cutting speed. Second, the number of cutting strokes per minute can be increased to 53 1/3 and still maintain the same cutting speed. Third, a larger cut or feed can be used and more stock be removed, and still maintain the same number of strokes of the ram with no more power used.

We leave it with the impartial reader to decide whether these gains of 33 1/3 per cent are of value in the day's production. We have shapers that have been working constantly, day in and day out, for twelve years (the oldest shapers we have), making a saving with every stroke and they are running today without, in the meantime, one cent having been expended for repairs—and after all is said, that is the real answer.

STOCKBRIDGE MACHINE CO.

Worcester, Mass.

## GRINDING ALUMINUM CASTINGS ON A VERTICAL SPINDLE DISK GRINDER

It is generally considered rather difficult to machine aluminum castings, similar to those shown in the illustrations, because of the action of aluminum on cutting tools and its tendency to spring when being clamped for machining on the miller, shaper or planer. Some interesting results of tests made in the experimental department of the Gardner Machine Co., Beloit, Wis., in connection with the grinding of large aluminum castings on the Gardner vertical-spindle disk grinder, are given in the following.

The aluminum gear-case and cover shown to the left in Fig. 1, each has a surface area to be ground consisting of a

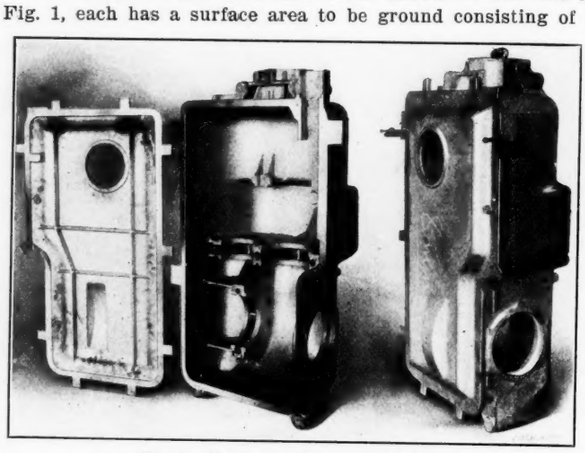


Fig. 1. Aluminum Gear-case and Cover

band 1 inch wide having the general shape of a rectangle measuring approximately 38 inches by 21 inches. The lugs or ears at the side also add about 12 inches of area to this surface. The case was finished on a vertical spindle machine having a 53-inch disk wheel, in seven minutes and the cover required eight minutes. The castings were ground from the rough, and a clean straight surface produced, as indicated in the view to the right, which shows the parts fastened together by small clamps placed near one end.

When castings are ground in a machine of this type, they are fed against the wheel by gravity pressure. This pressure

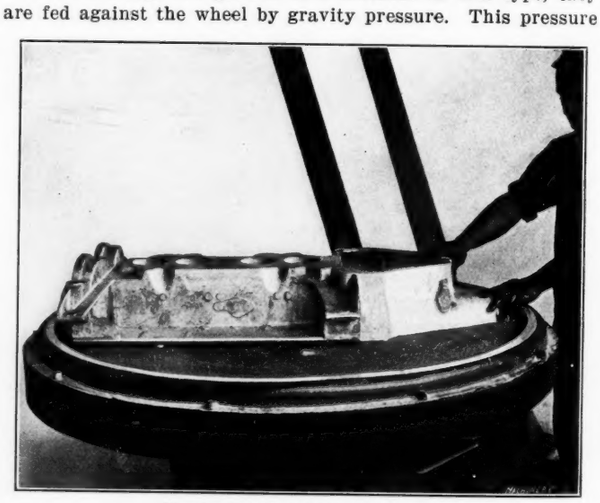


Fig. 2. Grinding Motor Crank-case

should be at least two pounds per square inch of aluminum surface to be ground. The weight of the gear-case was sufficient to give this pressure, but the cover, which had just as much area to be ground, required an additional weight of forty pounds. In this connection, it should be mentioned that the Gardner Machine Co. emphasizes the importance and advantage of reducing the surface area wherever practicable. For example, it is claimed that if the lugs or ears of the part shown in Fig. 1 were depressed below the finish line and if a shallow groove, say ⅜ inch wide, extended entirely around the center of the 1-inch band, both the case and its cover could be ground to a practically perfect surface, in from three to five minutes each. Depressions in the patterns having a

depth of from 1/32 to 1/8 inch, according to the size and accuracy of the casting, would produce the desired result.

Fig. 2 shows the method of grinding the upper half of an aluminum crank-case for a four-cylinder motor. The entire length of the surface being ground is 49 inches and the maximum width 13 inches. It required ten minutes to produce a straight and clean surface. If the surface area, however, had been reduced, as suggested in the foregoing, the time required for grinding could, according to a conservative estimate, have been diminished two or three minutes for each casting. This

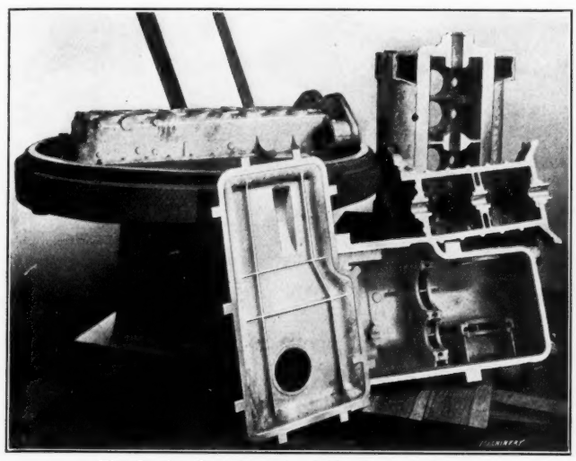


Fig. 3. Another Example of Aluminum Grinding

illustration shows very clearly the method of handling work of this class on the vertical spindle machine.

Fig. 3 illustrates a group of aluminum pieces all of which have been machined. The casting shown on the disk-wheel is the upper half of a motor crank-case, and it measures, diagonally, 51 inches. The suggestion in regard to the reduction of surface area, also applies to all of these parts and particularly to the one standing on end in the rear. This casting required thirteen minutes for finishing, but by depressing a portion of the surface area, it should be done in five minutes at the most.

## BEST MFG. CO.'S NEW PLANT AT OAKMONT, PA.

The new plant of the Best Mfg. Co. is located at Oakmont, some twelve miles up the Allegheny River from Pittsburg. This plant is devoted to the manufacture of valves, pipe fittings, pipe bends, special castings, etc. The plant is located between the tracks of the Pennsylvania Railroad and the bank of the Allegheny River, and is served by a spur track radiating from its own special station, Edgewater.

The main buildings are the machine shop, foundry and power house. The machine shop is 432 feet long by 128 feet wide; the foundry 320 feet long by 176 feet wide; and the power house 128 feet long by 55 feet wide. The machine shop, foundry and power house are of steel frame construction with brick curtain walls and cement tile roofs on steel trusses. These buildings are provided with exceptionally high windows, giving excellent lighting at all points in the building.

The foundry is equipped with molding machines, metal flasks for standard work, special shaped patterns, and metal core boxes for smaller work. The foundry is also supplied with jib traveling cranes to serve the ladles and handle the lighter local traffic. The two cupolas which are located in the south bay of the foundry have a capacity of 12 and 30 tons per hour; they are charged from the second story floor and served by a hydraulic plunger elevator.

In the machine shop electric drive is used throughout, the larger tools having individual motors and the smaller ones being driven in gangs from countershafting. The machine shop is equipped with the following tools: one open-side planer, one vertical and horizontal boring mill, smaller boring mills, turret lathes, ordinary lathes, large and small tapping machines, double-head facing lathes, multiple-spindle drills, single drills, a gang of pipe threading machines, and other special tools.

In the pipe shop is located an interesting furnace and bending table for bending large pipes. The pipe to be bent

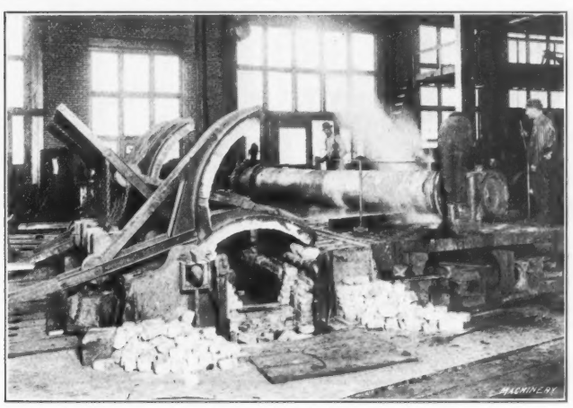


Fig. 1. Pipe in the Process of being bent

is filled with sand by gravity from an overhead hopper. The ends are plugged and the pipe placed in the gas furnace shown in Fig. 1, where that portion which is to be bent is heated to the proper temperature. This furnace is of interesting construction as can be seen by referring to Figs. 1 and 2. The top of the furnace consists of a number of iron segments lined with fire-brick and provided with weights which practically counterbalance the weight of the segments. When the pipe is heated to the proper temperature, an electric crane lifts the pipe vertically out of the furnace, the segments

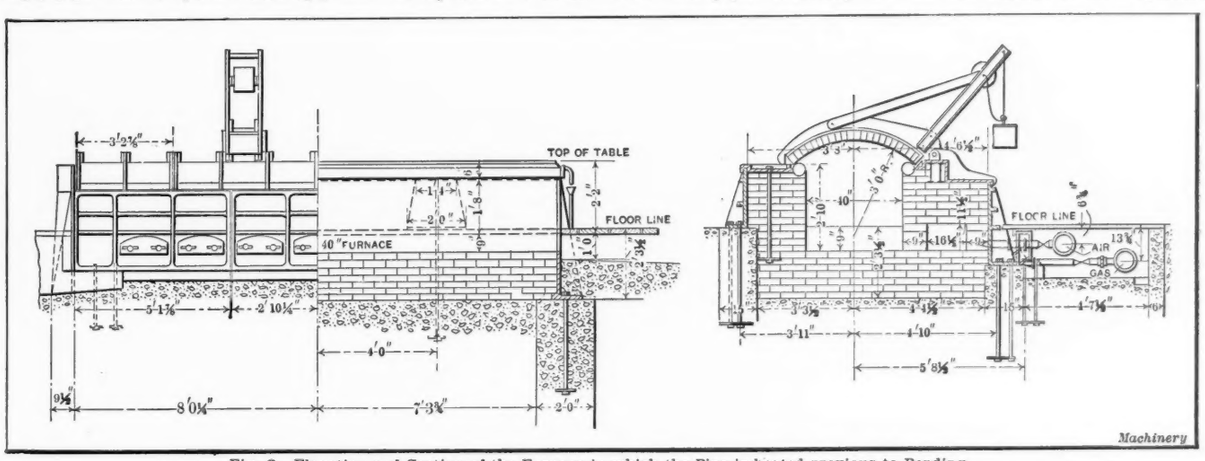


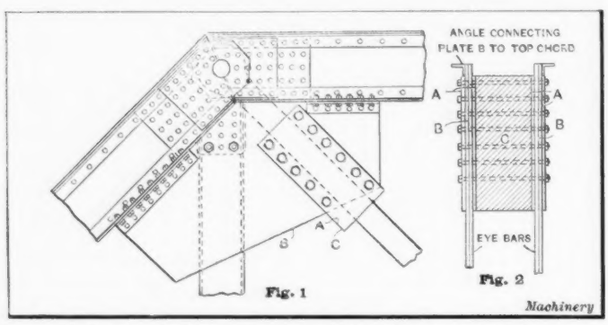

Fig. 2. Elevation and Section of the Furnace in which the Pipe is heated previous to Bending

dropping back to allow it to be removed easily. The pipe is removed from the furnace and is placed on the bending table, where, by means of an electric winch, it is bent around pins which are placed in such a position that they give the pipe the proper curve or angle. The object in filling the pipe with sand is to prevent it from buckling while being bent. After the pipe is bent, the sand is emptied into a tank below the floor level, from which it is blown upward to the gravity hopper.

## AN EXCEPTIONAL BRIDGE REPAIR JOB

One of the most interesting bridge repair jobs on record, both from a mechanical and a financial standpoint, was recently performed on one of the Chicago bridges of the Chicago, Milwaukee & St. Paul Railroad. The bridge in question is situated on the north branch of the Chicago river, between Division Street and North Avenue, and it was built in 1902. On account of the small width of the river and the necessity of keeping an open channel, a "through truss swing type" of bridge was used. It is two hundred and thirty feet in length, has unequal arms, and is pivoted on the north bank. The long arm extends across the river and is counterbalanced for overhang.

Due to vibration and other intermediate forces, the pins and bearings became so worn that it was deemed advisable to replace them. Previous to this time, all such jobs had been performed by driving piling and erecting false work, under which conditions the members were removed to the shop and rebored. Even under the most favorable circumstances, such a rush job would have hindered navigation for several days, and the expense would have been enormous. On account of the river traffic, some trouble was experienced in receiving Government permission to shut off navigation, so it was finally




Figs. 1 and 2. Method of Holding Bridge Members while Holes were being bored

decided to try a new scheme for boring out the holes and replacing the worn pins with larger ones, without removing any of the members.

Preparatory to removing each pin, it was necessary to clamp the members at the joint as shown in Figs. 1 and 2, to secure them during the boring operation. Four steel plates

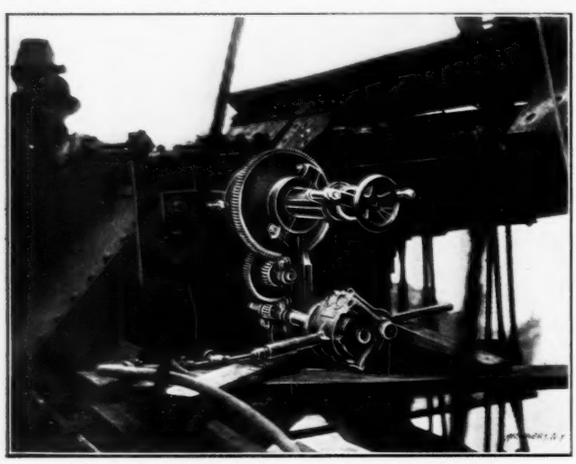


Fig. 3. Ryerson Boring-bar in Position for Boring Holes

*A* were used to hold the eye-bars, and these were placed on each side of the eye-bars with a block of wood *C*, fitting tightly between the inner two, while the outer two reinforced the plates *B* which were directly in contact with the eye-bars. The whole was bolted together by one-inch bolts, thus developing enough friction between the plates to take care of the dead load stress on the eye-bars. The two plates *B* were fastened to the lower flange of the top chord and to each end post by angles and bolts, and the hanger was supported by bolts as shown. In this manner all the members were rigidly clamped in position, so that the pins could be driven out.

Upon removing the pins, they were found to be considerably worn and their bearings somewhat enlarged. The holes were rebored from the original 5-inch diameter to 5¼-inch diameter by using one of the portable boring-bars made by Joseph T. Ryerson & Son of Chicago. This type of boring-bar, as is well known, is designed primarily for boring locomotive cylinders in the shop. Fig. 3 shows the boring-bar in position and the manner of bracing and centering it with one of the holes. Fig. 4 is a view from below. The power plant consisted of a section car, containing a gasoline engine and air compressor. The boring-bar was directly driven by a

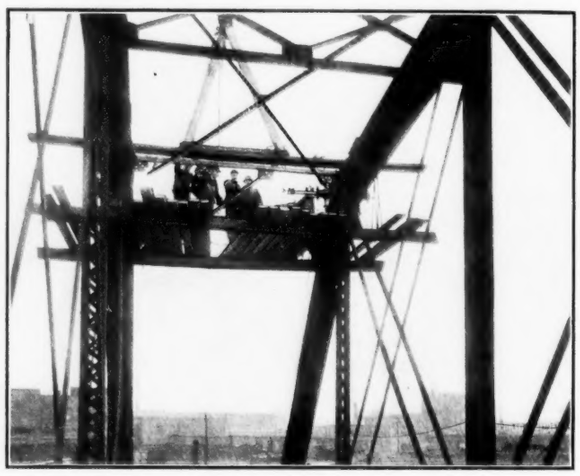


Fig. 4. View showing Boring-bar at Top of Bridge

small air drill which operated the shaft and furnished the required power.

Work on this job was started at 6:00 A. M. on the morning of November sixth and by 8:15 P. M. of the same day, the four pins had been removed, holes rebored, new pins inserted, and traffic was passing over the bridge. This is the first time that the use of such a method of reboring bridge work has ever been brought to our notice. The time taken for the actual work was remarkably short, and the whole experiment proved a decided success.

* * *

## ANNUAL MEETING OF THE A. S. M. E.

The thirty-second annual meeting of the American Society of Mechanical Engineers was held in the Engineering Societies Building, New York, December 5 to 8 inclusive. The meeting was one of the most successful in the society's history. The attendance was large, the registration being 687 members and 1212 total, including guests. The papers presented covered a wide diversity of subjects including three by the first sub-committees appointed—those on textiles, cement manufacture and machine shop practice.

The technical excursions included inspection of the White Star steamer *Olympic*, the largest vessel afloat; Edison laboratories at West Orange, N. J.; Bush Terminal Co.'s plant in Brooklyn; Brooklyn Navy Yard; E. W. Bliss Co.'s plant, Brooklyn; J. H. Horton's ice cream plant, New York; Ward Bread Co.'s plant, New York, etc. These excursions were so arranged as not to interfere with the regular sessions. The technical program was as follows:

"The Engineer in the Future," by Col. E. D. Meier (president's address).

"The Turret Equatorial Telescope," by James Hartness.

"Expense Burden," by Sterling H. Bunnell.

"Standard Cross Sections," by H. deB. Parsons.

"Tests of Large Boilers at the Detroit Edison Company," by D. S. Jacobus.

"Strain Measurements of Some Steam Boilers Under Hydrostatic Pressures," by James E. Howard.

"Herringbone Gears," by P. C. Day. (Contributed by the sub-committee on machine shop practice.)

"The Dust Problem in Portland Cement Plants," by Otto Schott.

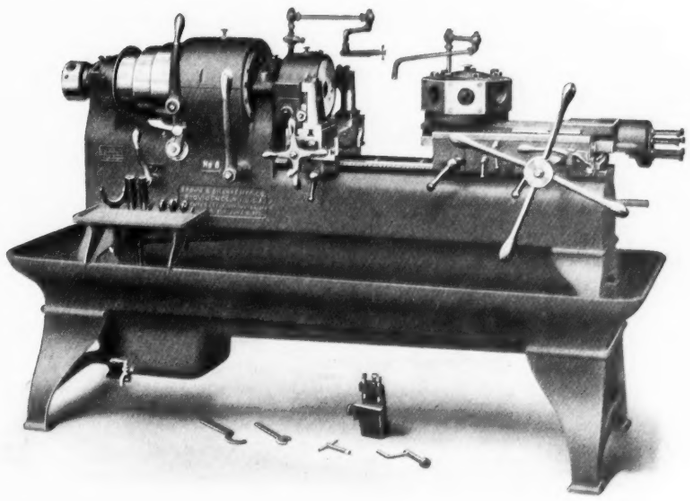
"Confirmation of the Advantages of Electricity to the Cement Manufacturer," by J. D. Porter.

"Electrical Power in Cement Plants," by Frederick H. Lewis.

"Protection of Laborers from Accidents and Injury to Health in Cement Plants," by Otto Schott.

"Methods and Appliances for Prevention of Accidents in Cement Plants," by J. G. Bergquist.

**These machines are adapted for the rapid production of duplicate parts in small lots.**



# B. & S. Wire Feed Screw Machines

Unless the volume of any one kind of work in a shop is sufficient to warrant the installation of automatic machines, the wire feed type is the most economical to employ. Because they are adapted for such work, they embody many conveniences to aid in setting up and operating.

A glance at the sizes of the machines in the line will emphasize their range. They are as follows:

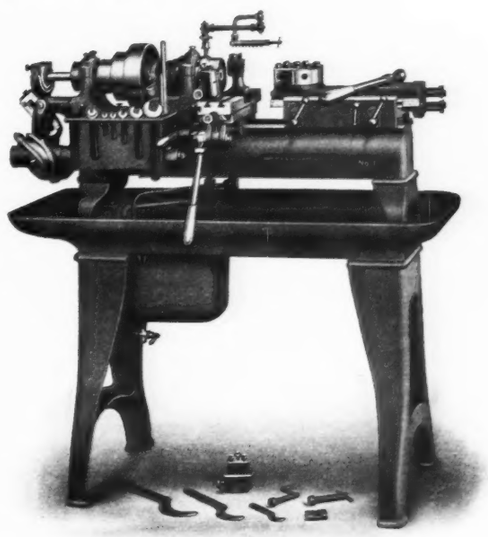
No. 0 takes stock 3/8" diameter; turns to 2¼" length.

No. 1 takes stock 5/8" diameter; turns to 3" length.

No. 2 takes stock 7/8" diameter; turns to 4" length.

No. 4 takes stock 1¼" diameter; turns to 8".

No. 6 takes stock 1½" diameter; turns to 10".



See our Catalogue for detailed descriptions. Sent on request.

**BROWN & SHARPE MFG. CO.**

**Providence, R. I., U. S. A.**

"Geo-Dynamics or the Mechanics of the Formation of Worlds," address by Dr. Robert Simpson Woodward, president of Carnegie Institution of Washington.

"The Core Room: Its Equipment and Management," by Henry M. Lane.

"Tests of a Sand-Blasting Machine," by Wm. T. Magruder.

"Die Castings," by Amasa Trowbridge.

"Variable-Speed Power Transmission," by G. H. Barrus and C. M. Manly.

"Oil Engines," by H. R. Setz.

"Test of an 85-H. P. Oil Engine," by Forrest M. Towl.

"Design Constants for Small Gasoline Engines," by Wm. D. Ennis.

"1000-KW. Natural Gas Engine: Tests, Construction and Working Costs," by E. D. Dreyfus and V. J. Hulquist.

"The Development of the Textile Industries of the United States," by Frank W. Reynolds. (Contributed by the subcommittee on textiles.)

"Rational Psychrometric Formulas: Their Relation to the Problems of Meteorology and of Air Conditioning," by W. H. Carrier.

"Air-Conditioning Apparatus," by W. H. Carrier and F. L. Busey.

"Experiences with the Pitot Tube on High and Low Air Velocities," by Frank H. Kneeland.

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## DR. ALEXANDER C. HUMPHREYS

Dr. Alexander C. Humphreys, president of Stevens Institute of Technology, and one of the foremost of American gas plant engineers, was installed as president of the American Society of Mechanical Engineers, December 5. Col. E. D. Meier, the retiring president, made the installation address in which he outlined Dr. Humphreys' career, as follows:

"Mr. Humphreys entered Stevens Institute of Technology with the class of 1877, handicapped as few men ever were. It

Dr. Alexander C. Humphreys

had been twelve years since he had last attended school and that at the age of fourteen. Besides the necessity of providing for his young wife and two children, he had been elected to several positions of trust and honor in the town of Bayonne, New Jersey, all of which drew upon his time and strength. In the face of all these circumstances, which would have seemed insurmountable to the average man, Mr. Humphreys graduated from Stevens Institute with the class of 1881, having accomplished for the most part at night, after a day's work had already been done elsewhere, what normal students fresh from advanced schooling accomplish only by the unremitting application of all their working time.

"Soon after graduation, he became chief engineer of the Pintsch Lighting Co., of New York. In 1885, he was made superintendent of construction for the United Gas Improvement Co., and shortly afterward took the position of general superintendent with headquarters in Philadelphia. Eventually he assumed control of the entire commercial management of all the company's works, including the Welsbach Incandescent Lighting Co., which at that time was a subsidiary of the United Gas Improvement Co.

"In August, 1894, Mr. Humphreys retired from his official relations with the United Gas Improvement Co., to establish the firm of Humphreys & Glasgow, of New York, recently succeeded by the firm of Humphreys & Miller, Inc., of which he is president. In June, 1902, he was elected president of Stevens Institute of Technology, by unanimous vote of the trustees. In 1903, the degree of doctor of science was conferred upon him by the University of Pennsylvania and the degree of doctor of laws by Columbia University. New York University also conferred the degree of doctor of laws in 1906 and Princeton University in 1907.

"Dr. Humphreys has been chief executive officer of more than fifty-five gas and electric light companies, and is now president of the Stevens Institute of Technology, Humphreys & Miller, Inc., gas engineers, and the Buffalo Gas Company. He is a director in the Equitable Life Assurance Society, a member of its executive committee, and a trustee member of the executive committee of the Carnegie Foundation for the Advancement of Teaching. He is a member of almost every prominent technical society in this country; of the Delta Tau Delta Fraternity, and of many clubs and philanthropic societies."

* * *

## PERSONALS

C. L. Eshleman has been appointed publicity manager of the Adams-Bagnall Electric Co., Cleveland, Ohio, with headquarters in Cleveland.

Harry A. Hey, associate editor American Society of Mechanical Engineers, New York, has been made office manager of the society, succeeding S. E. Whitaker resigned.

William Dayton of the Excelsior Needle Co., Torrington, Conn., will leave, the first part of January, for a business trip through Germany in the interests of his company.

William H. McIntyre, formerly fourth vice-president of the Equitable Life Assurance Society, has been elected first vice-president of Manning, Maxwell & Moore, Inc., New York.

J. G. Pomeroy, formerly Western sales manager of the Adams-Bagnall Electric Co., Cleveland, Ohio, has been appointed sales manager of the company with headquarters in Cleveland.

Thomas L. Carter, for several years assistant foreman of the small motor department of the Lynn works of the General Electric Co., has been appointed foreman of the general tool-making department of the Lynn works, succeeding A. A. Fountain, who recently resigned.

D. M. Motherwell, formerly general superintendent of the Whitman & Barnes Mfg. Co., Akron, Ohio, is now superintendent of the Armstrong Bros. Tool Co., Chicago, Ill. Mr. Motherwell is engaged in designing a new and complete line of drop-forged wrenches which will soon be placed on the market by the Armstrong Bros. Tool Co.

Lionel Samuel, director and joint manager of Cammell Laird & Co. of New York, is not seeking re-election next year, his personal affairs requiring his entire attention. As general agent of the English company, he established its offices here some years ago. Mr. Samuel is not only well known in New York, but also in Mexico and Central and South America, with some of whose governments he has had large business relations.

Walter B. Snow, Boston, Mass., announces the recent addition to his staff of Mr. Sidney G. Koon, for four years editor of *International Marine Engineering*, and later metallurgist with Jones & Laughlin Steel Co., and also the addition some time since of Mr. John S. Nicholl, lately with the New York Edison Co., and formerly acting manager for F. W. Horne, importer American machinery, Yokohama, Japan. Both are members of the American Society of Mechanical Engineers.

Donald D. Simonds (W. P. I., '08), for the past three years with the Reed & Prince Mfg. Co., Worcester, Mass., has taken a position as assistant superintendent with the F. W. Bird & Sons Co., Walpole, Mass., in charge of the company's box factory. Mr. Simonds was presented with a fine black walrus skin bag equipped with the customary toilet articles, and a silk umbrella with a silver mounted handle, by the department foremen previously under his supervision, as an evidence of their friendship.

Ira Gould Hoagland has been appointed editor and manager of *Insurance Engineering* and assumed his new duties January 1. Mr. Hoagland was born in Brooklyn, N. Y., 1877, and was educated in the Brooklyn public schools and Pratt Institute where he took the electrical and mechanical engineering courses. He entered the insurance business in 1896, and gained experience with the several concerns with which he was connected in various capacities that well fits him for his present responsible position.

R. T. Wingo, a well-known mechanical expert has joined the Hupp Corporation, Detroit, Mich., automobile manufacturer, as assistant general manager in charge of production, and acting master mechanic and consulting engineer. Mr. Wingo was for ten years employed with the Brown & Sharpe Mfg. Co., working successively as machinist, inspector, foreman and machine designer. He spent two years abroad with one of the large tool manufacturing concerns of Germany, and upon his return to America joined the engineering staff of the Cadillac Motor Car Co., of Detroit, from which he went to the Hupp Corporation.

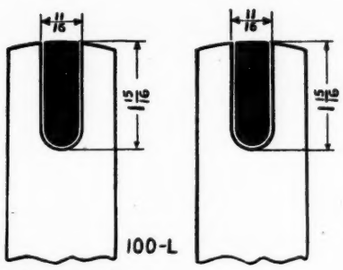
* * *

## OBITUARIES

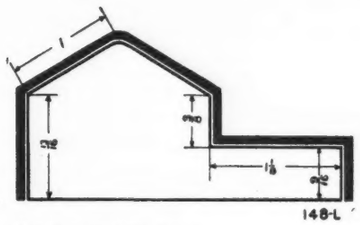
Caryl D. Haskins, manager of the lighting department of the General Electric Co., Schenectady, N. Y., and one of the

## Some Examples of Work done on the

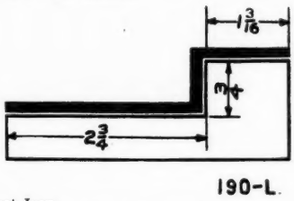
# No. 2 Plain Cone Driven Cincinnati Miller



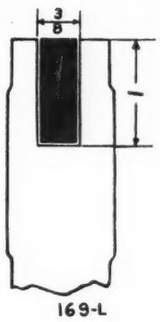

Material, 40 Carbon Steel.
Size of cut, 11-16" wide, 1" deep, 1 15-16" long.
Cutters, 6" in diameter.
Two Pieces are milled at one time.
The work is held horizontally and fed directly into the Cutter at a travel of 1" per minute.



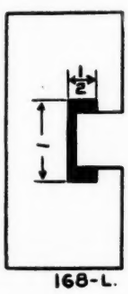

Material, Cast Steel.
Total width of cut, 5".
Depth of cut, 1-16" to 3-32".
Thickness of piece, ⅞".
Largest Cutters, 5½" diameter, 53 revolutions.
Feed, 2.9" per minute.
Four Pieces are held in a jig at one time.
Total time per piece, 1¼ minutes.



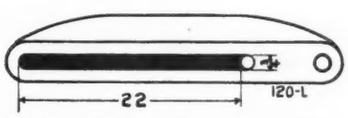

Material, Cast Iron.
Total width of cut, 4 11-16"; depth of cut, ⅛"; length of cut on each piece, 1⅛".
Cutters, 4½" and 3" diameter.
Twenty-four Pieces are held in a string jig at one time.
Feed, 1⅞" per minute.
Finished surfaces are accurate within .001."




Material, Steel Forgings.
Cut consists of a slot 1" deep, ¾" wide at a table travel of 4" per minute.
Cutter, 3½" in diameter, ⅝" face, 53 revolutions.
The pieces are of irregular form and 5 of them are held in a string jig at one time. The length of cut in each piece is approximately 1".

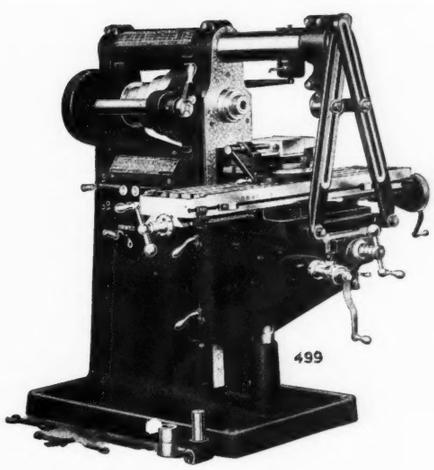



Material, Cast Iron.
Cut consists of undercutting T slots, with a Cutter 1" diameter, ½" face, running 286 revolutions. Our average rate of feed on this work is 15⅝" per minute.




Material, Cast Iron Bars. 1" thick.
A slot ¾" wide is cut through the solid at one cut, starting from a drilled hole with a ¾" diameter, 3 fluted end mill at 3⅝" table travel per minute.
Metal removed per minute is equivalent to a bar 1" x ¾" x 3⅝" long. Actual cutting time for slots 22" long, 6 minutes.

For the usual Tool Room work; for repair work; for manufacturing small machine parts—in fact, for all work on which the cutting is light, a modern Cone Driven Miller will bring you bigger returns for your investment than a Single Pulley Drive Machine.




We have redesigned ours, brought them up to date, made them handier than ever before, and we are offering a full line for all that work for which they are especially adapted.

We also make a full line of single pulley High Power Millers for the heavier classes of milling.

## The Cincinnati Milling Machine Company

CINCINNATI, O., U. S. A.

foremost electrical engineers of the country, died of pneumonia in Salt Lake City, November 18, aged forty-four years.

Richard N. Durborow, general superintendent of motive power, Pennsylvania R. R., east of Pittsburg, died December 8 at the Hotel Walton, Philadelphia, of acute pneumonia after an illness of only a few hours, aged fifty-one years. Mr. Durborow held the office of superintendent of motive power of the Eastern division of the Pennsylvania R. R., from 1901 to 1911, and was promoted to the position of general superintendent of motive power a few months ago, succeeding A. W. Gibbs, promoted to the position of chief mechanical engineer. Mr. Durborow was educated at Cheltenham Academy and the Maryland Military Institute. In 1879 he entered the services of the Pennsylvania R. R., in the West Philadelphia shops, as an apprentice. He served in that capacity until March, 1880, when he was transferred to the Altoona shops in Altoona, Pa., where he worked until 1883. He then entered the drafting-room and remained there until 1890. The two succeeding years he was employed as an inspector in the West Philadelphia shops, and from 1892 until the close of 1895 he was the assistant general foreman of the West Philadelphia shops. In November, 1895, he was then appointed acting master mechanic of the West Philadelphia shops, which position he held until 1900. For a short time in 1900 he was superintendent of motive power of the Philadelphia, Baltimore & Washington R. R., and from August 1, 1900 to October 1, 1901, he was superintendent of motive power of the Buffalo & Allegheny Valley division, Pennsylvania R. R., at Buffalo. Mr. Durborow married Miss Helen McCormick in 1887. He died leaving no children. Mr. Durborow's death is keenly felt in Altoona, both in the shops and in the town. The feeling is that they have lost one who was deeply and sincerely interested in the growth of the town and the advancement of the company's employes.

* * *

## COMING EVENTS

January 6-13.—Passenger automobile exhibition, Madison Square Garden, New York.

January 10-17.—Combined passenger and commercial car exhibition, Grand Central Palace, New York. S. A. Miles, manager, 7 East 42nd St., New York.

January 15-20.—Commercial vehicle exhibition, Madison Square Garden, New York.

January 18-20.—Annual meeting of the Society of Automobile Engineers in New York. Coker F. Clarkson, general manager, 1451 Broadway, New York.

January 27-February 3.—Passenger automobile exhibition, Coliseum and First Regiment Armory, Chicago, Ill.

February 5-10.—Commercial vehicle exhibition, Coliseum and First Regiment Armory, Chicago, Ill.

May 14-17.—Sixth annual convention of the Master Boiler Makers' Association at the Fort Pitt Hotel, Pittsburg, Pa. J. R. Flannery, of the Flannery Bolt Co., Frick Bldg., Pittsburg, Pa., secretary and treasurer of the general committee of arrangements.

June 12-14.—Annual convention of the American Railway Master Mechanics' Association at Atlantic City, N. J.

June 17-19.—Annual convention of the Master Car Builders' Association at Atlantic City, N. J.

August 20.—Annual convention of the International Railroad Master Blacksmiths' Association at Hotel Sherman, Chicago, Ill. J. E. Carrigan, Rutland Railway, Rutland, Vt., chairman of the executive committee.

September 2-7.—Sixth congress of the International Association for Testing Materials at the Engineering Societies Building, 29 W. 39th St., New York. One of the important functions of this association is to establish standard specifications for materials used in manufacture and construction. The cooperation of engineers and others who are engaged in the purchase and use of the raw materials of the trades, is requested. The annual dues are $2, with no initiation fee. Mr. H. F. J. Porter, secretary, 1 Madison Ave., New York.

## SOCIETIES AND COLLEGES

Williamson Free School of Mechanical Trades, Delaware Co., Pa. Bulletin No. 8, containing an outline of the machinist's trade course. Outside of the practical features of the machinist's trade in which instructions are given, shop talks on various subjects touching upon mechanical work are a feature of the instruction. Subjects touched upon are: motion study; tool making as a part of the machinist's trade; jig and fixture data; machine shop calculations, etc. The bulletin also gives a detailed review of the courses.

National Metal Trades Association. Draft of a proposed bill to regulate the manufacture of explosives prepared by the legal department of the association. The bill provides that any person, partnership or corporation manufacturing, handling, storing, selling or dealing in dynamite, gunpowder, giant powder, nyalite, joveite, masurite, nitro explosive, and other high explosives shall be subject to certain regulations affecting the manufacture, selling, handling and dealing in said explosives. It is proposed to secure the enactment of the bill by the legislatures of the various states. Copies of the bill can be had by application to Robert Wuest, commissioner of the National Metal Trades Association, New England Bldg., Cleveland, Ohio.

## NEW BOOKS AND PAMPHLETS

Mechanical World Electric Pocketbook for 1912. 224 pages, 4 by 6 inches. 80 illustrations. Published by Emmott & Co., Ltd., 65 King St., Manchester, England. Price, 6d.

The 1912 edition of this pocketbook has been enlarged by the addition of sixteen pages containing matter of importance to the electrician. A number of improvements have also been effected in various sections of the work. Thus the matter devoted to lighting has been entirely rewritten, and a new section on motor starters has been introduced, as well as one on static transformers and on the construction, rating and testing of high tension apparatus. Several new tables have also been included.

Technology and Industrial Efficiency. 486 pages, 6 by 9 inches. Published by the McGraw-Hill Book Co., New York. Price, $3.00.

This book contains a series of papers presented at the Congress of Technology held in Boston, Mass., during April, 1911, in celebration of the fiftieth anniversary of the granting of a charter to the Massachusetts Institute of Technology. About seventy papers are included, forming a valuable and up-to-date record of the present state of the industrial sciences, and a presentation of some modern industrial problems and their probable solution. The six sections into which the congress was divided are represented by papers on scientific investigation and control of industrial processes; technical education in its relations to industrial development; administration and management; recent industrial development; public health and sanitation, and architecture.

Railroad Operating Costs. By Suffern & Son. 82 pages, 8 by 11 inches. Numerous diagrams and plates. Published by Suffern & Son, New York. Price, $2.00.

The purpose of this book is to present some facts relating to railroad operation which will throw some light on the operating costs, through comparisons of vital factors in the management of leading railways. It is divided into six chapters, of which Chapter I deals principally with general conditions of railway operation, such as capitalization, earnings, density of traffic, percentage of operating expenses, etc. Chapter II deals with general divisions of operating expense; Chapter III, with the maintenance of way and structures, and Chapter IV, with the maintenance of equipment. Chapter V is devoted specifically to the conditions met with in conducting transportation proper, and deals with the cost of supervision, cost of fuel, claims, damages, trainmen's wages, etc. Chapter VI consists of a general summary.

## NEW CATALOGUES AND CIRCULARS

Blanchard Machine Co., Cambridge, Mass. Circular of the Blanchard oil engine, designed by Walcott Remington. The engine is of the two-stroke cycle type and uses crude oil fuel. It is made in sizes from 8 to 100 horsepower for stationary and marine use.

Gould & Eberhardt, Newark, N. J. Circular of the vertical cutting type automatic gear cutting machine for spur, bevel and face gears having capacity for spur gears 24 inches diameter, 8 inches face, and 36 inches diameter when stripped of the mandrel supports.

Universal Boring Machine Co., Hudson, Mass. Catalogue of Universal (horizontal) boring machines built in Nos. 2½ and 3 sizes. This machine is of the right-handed type, the head being placed on the right-hand side. The catalogue illustrates details of construction throughout.

National Automatic Tool Co., Richmond, Ind. Illustrated circular descriptive of the National adjustable multiple-spindle drilling machine, type M, with independently changeable spindle speeds. Different sized holes can be drilled simultaneously with each drill running at its approximately proper speed.

Tapley Specialty Co., New York. Card illustrating the Tapley elevating truck for handling materials in shops, mills and factories. The truck is used in connection with platforms on which the materials are supported in position to be instantly loaded when requiring to be removed. The system saves much time and labor in handling.

Hess-Bright Mfg. Co., 2111 Fairmount Ave., Philadelphia, Pa. "The Requirements of a Ball Bearing Grease," by Herbert L. Towle. The character of lubricant used with ball bearings is highly important, and the points to be observed in the selection of a grease are emphasized. Users of ball bearings will find the matter of considerable value.

Cincinnati Milling Machine Co., Cincinnati, Ohio. Bird's-eye view of the new factory at Oakley, a suburb of Cincinnati. The company's new buildings contain 275,000 square feet of floor space (exclusive of the power plant) and represent the most advanced ideas in factory construction as to lighting, heating, ventilation and routing of materials.

General Electric Co., Schenectady, N. Y. Bulletin No. 4892 on battery truck cranes for shop, factory, dock and warehouse use. The machine is a short, heavy, storage battery vehicle, having mounted on its forward end a swinging crane, the hook of which is raised and lowered by a one-ton hoist operated by the battery. See MACHINERY, November, 1911, for illustrated description.

South Bend Machine Tool Co., South Bend, Ind. Catalogue No. 41 of foot and power screw-cutting engine lathes, comprising 9-inch, 11-inch, 12-inch and 13-inch swing, equipped for countershaft or foot power. The 9-inch swing lathe is also made with short legs for use on a bench. Lathes are furnished with gear cutting attachment, spindle turret, turret on lathe carriage, or turret on bed, to order.

Joseph T. Ryerson & Son, 16th and Rockwell Sts., Chicago, Ill. Catalogue, 8½ by 11 inches, of Rockford heavy duty, variable speed and motor-driven planers, illustrating, with specifications, the 24-inch, 28-inch, 32-inch and 36-inch sizes; also the 32-inch size with variable speed motor drive. The catalogue shows several interesting details of Rockford planer construction which merit the attention of planer users generally.

H. W. Johns-Manville Co., 100 William St., New York. Catalogue No. 50 on the "Audiffern" refrigerating machine for use in residences, hotels, dairies, grocery stores, hospitals, etc. The machine is extremely simple; it embodies a mechanical principle which eliminates all stuffing-boxes, valves and other openings to the atmosphere, hence the possibility of leakage of the refrigerating medium, sulphur dioxide, is eliminated.

Wiley & Russell Mfg. Co., Greenfield, Mass. Catalogue of "Lightning" and "Green River" screw-cutting machinery and tools, listing a large line of screw plates, including many sets in leather rolls and wood cases for automobile repair purposes. The catalogue also lists the company's large line of taps, spiral and straight fluted reamers, and other tools and machines. It contains in addition twenty pages of data particularly valuable to all mechanics.

Ingersoll-Rand Co., 11 Broadway, New York. Four-page bulletin, form 4108, on rock drills, descriptive of the B-104 Sergeant rock drill, which is a machine especially adapted for driving small headings, stoping or similar work requiring light and powerful machines. This drill has a 2½-inch cylinder, and will drill a 1-inch to 1½-inch diameter hole to a depth of 20 inches without change of steel. The bulletin illustrates the component parts of the drill and gives full specifications and details.

G. A. Gray Co., Cincinnati, Ohio. Catalogue of constant speed and variable speed Gray planers, built in standard dimensions from 22 by 22 inches to large sizes, and of various combinations of width and height. The catalogue illustrates forms of drive including motor drive mounted on top of the columns and on the floor, with and without the Gray patented speed variator; it also shows horizontal and vertical independent housings for increasing width and height capacity of standard planers.

When we first began to advertise the LUCAS TYPE Boring, Drilling and Milling Machine (THE "PRECISION"), we strongly and continuously EMPHASIZED the fact that the SPINDLE HEAD and the TAIL BLOCK AUTOMATICALLY rise and fall TOGETHER, but have lately found a few (of the younger generation) who did not understand this—so again we say:

**The Spindle Head and Tail Block are Raised and Lowered Together, being Connected by a shaft and Planed Bevel Gears.**

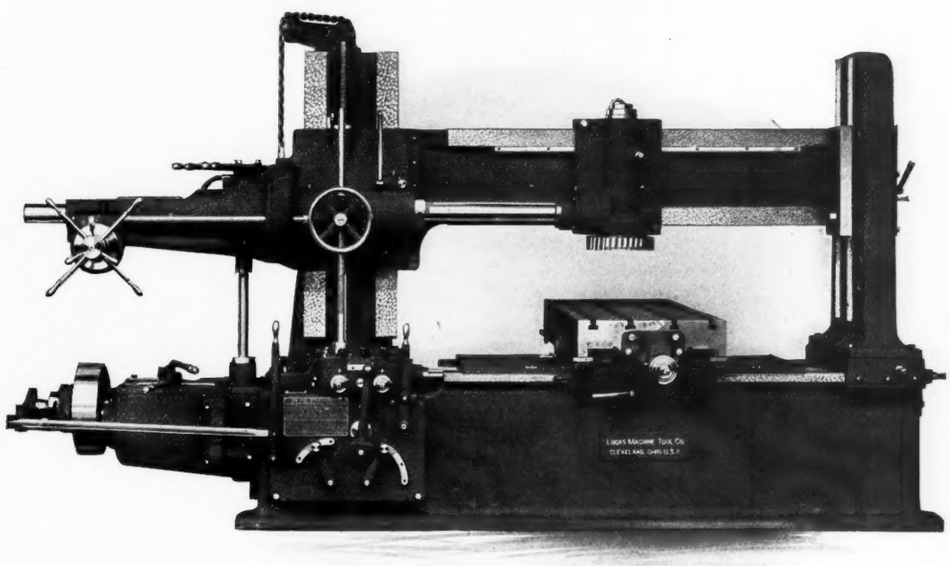
If it were NOT so, we would not have the courage to bring out the

## VERTICAL MILLING ATTACHMENT

which of course can be fed up or down and returned QUICKLY by POWER, the same as every other part of the machine is fed and returned.

**Now do you realize the possibilities of the**

# "PRECISION" BORING, DRILLING and MILLING MACHINE?



**COME AND SEE IT WORK IN OUR SHOP—
IT'S A SURPRISE EVEN TO US.**

**Lucas Machine Tool Co.,** NOW AND ALWAYS OF **Cleveland, O., U.S.A.**

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Berlin, Brussels, Paris, Milan, Barcelona, Bilbao. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal, Canada.

SCHROCK & SQUIRES, 291 Pearl St., New York. Catalogue and price list of Edgar Allen & Co., Ltd., crucible steels, comprising Allen's "Imperial" special high-speed steel; Allen's air-hardening high-speed steel; Allen's self-hardening high-speed steel; Allen's "Imperial" cast steel; Allen's class E extra refined cast steel; Allen's "Stag" cast steel; Allen's solid and hollow mining drill steel; "S and S" oil hardening tool steel; and valuable information on forging, hardening, oil hardening, annealing, pack-hardening, case-hardening and tempering steel.

HYATT ROLLER BEARING CO., Newark, N. J., has for some time made a practice of issuing bulletins covering in detail the ratings and capacities, indicated uses and actual application of its flexible roller bearings. Separate issues cover the different types, such as the long series for machine tools and similar work; short series for automobile service, standard shafting, special work, etc. These bulletins are at the call of anyone interested, and form a collection of special information on anti-friction bearings of value to all concerned with the transmission and use of power.

S K F BALL BEARING CO., 50 Church St., New York. Bulletin No. 1 on S K F radial bearings which embody the feature of self-alignment. The bulletin lists light, medium, heavy and extra heavy types, having capacities from 108 pounds at 2400 revolutions per minute to 17,400 pounds at 300 revolutions per minute. Light and medium type adapter bearings are also listed. These bearings are made with a collapsing bushing which grips the shaft and fixes the bearing in place when the collar nut is screwed up. The bulletin explains the construction peculiarities, particularly the provision for self-alignment.

CINCINNATI ELECTRICAL TOOL CO., 650-652 Evans St., Cincinnati, Ohio. Catalogue of "Peerless" electric drills built in many sizes and styles for use in every class of drilling in iron and steel up to 2¼ inches, and in wood up to 3 inches. These tools comprise portable electric hand and breast drills for direct and alternating current; portable reamers; Scotch radial drills; air-cooled portable toolpost grinders for external and internal grinding; air-cooled portable bench grinders with one and two wheels; air-cooled floor grinders; air-cooled portable aerial buffer or grinder, all adapted to alternating or direct current.

O. K. TOOL-HOLDER CO., Shelton, Conn. Catalogue No. 4 of the O. K. tool-holders for lathes, planers, shapers, boring mills and other machine tools. The O. K. tool-holders are put up in suitable boxes with various assortments of tools and fixtures suitable for all classes of work. Special sets for lathes, planers, and boring mills are illustrated. The catalogue also describes a remarkable test made with O. K. tools, and illustrates the lathe and the chips produced. Other matter of interest to mechanics, foremen, superintendents and others, makes the catalogue of unusual value to everyone concerned with machine shop practice.

HENDEY MACHINE CO., Torrington, Conn. Booklet entitled "Helps on Change Gearing and Thread Cutting for Users of Hendey Lathes." This booklet should be generally appreciated by users of Hendey lathes. It illustrates the standard index plates showing range of threads and feeds; metric transposing plates; index plates for metric engine lathes, and diagram of feed gears for 12, 14, 16, 18, 20 and regular engine lathes. Formulas are given for figuring gears for threads not given in index, and for figuring gears for metric threads in metric lathes. Other data and descriptive matter complete a booklet of value for engine lathe users.

CHARLES CHURCHILL & CO., 9 Leonard St., London, E. C. Catalogue of Churchill grinding machines, including cylindrical grinders of plain and universal types, internal grinders, vertical surface grinders and special ring-grinding machines. The principal features of these grinders are described in detail and carefully illustrated. There is also a great deal of practical information on grinding, covering such subjects as the care of the machine, preparation of the work, use of steadyrests, adjustment of machine for grinding, wheel and work speeds, causes of error, importance of wet grinding, internal grinding, selection of wheels to secure efficient results, etc. In addition, typical examples of external and internal work are illustrated, and many practical points given. There are also a number of useful tables and miscellaneous data.

KEARNEY & TRECKER CO., Milwaukee, Wis. Catalogue No. 18 of "Milwaukee" universal, manufacturing and plain milling machines. Interesting details of construction are shown and described, comprising box knee; table, swivel carriage and saddle; standard, right angle and electric drives; the lubrication system by which every bearing is automatically flooded with lubricant; tumbler support and spindle reverse; feed box; feed reverse; feed interlocking device, etc. Various examples of milling are also shown. The accessories comprise: vertical spindle attachment, vertical spindle with rack cutting attachment, universal milling attachment, slotting attachment, plain centers, universal centers, spiral universal centers, rotary table, etc. Several pages are devoted to operation instructions, including diagrams for determining pulley speeds and cutter speeds without calculation.

CINCINNATI PLANER CO., Cincinnati, Ohio. Placard emphasizing seven points that make for planer quality, as follows: 1.—Adopt every improvement which will increase the efficiency of our machines regardless of cost. 2.—Let every workman know that we want quality first, last, and all the time. 3.—Never hesitate to discard a piece that has a defect in material or workmanship. 4.—Verify all tests made and never accept any work from another department that has a slight defect in workmanship. 5.—Provide all workmen with the best of facilities, high grade gages, measuring instruments, etc. 6.—Purchase only the best materials that can be had for the purpose, and verify their quality by laboratory tests. 7.—Each machine must test inside the limits of error specified, and test card made out and sent to the office. All machines must be belted and operated under actual working conditions before shipping.

DODGE MFG. CO., Mishawaka, Ind. Wall poster in colors showing the covers of twenty-two catalogues, circulars and advertising devices embracing practically everything required for the mechanical transmission of power. The catalogues shown are as follows: Catalogue C–7, Library Edition; Catalogue C–7, Pocket Edition; Power and Transmission (Dodge Monthly Magazine); No. 18, A Remarkable Test of an Iron Center Wood Rim Pulley; No. 99, Condensed Price List of the Dodge Line; No. 56, Dodge Calculator; No. 101, Dodge Keyless Compression Couplings; No. 20, Dodge Pulleys; No. 116, Friction Clutches; No. 77, From Log to Line Shaft; No. 115, Hanger Bulletin; No. 92, Hanger Price List; No. 3, Hardwood Lagging; No. 98, Harnessing Water Power; No. 108, Roadbed for Power; No. 123, Safe Construction and Speeds for Flywheels; No. 62, Something About Friction Clutches; No. 86, Standard Iron Split Pulley Price List; No. 57, The Construction of a Modern Cement Mill; No. 107, The Conversion of Mr. Pennywise; No. 76, Twenty-five Years of Rope Driving; No. 104a, Wood Split Pulley Price List.

## TRADE NOTES

KERR TURBINE CO., Wellsville, N. Y., states that over 700 Kerr turbines, aggregating more than 50,000 horsepower, are in service, and that the company has more unfilled orders booked than at any previous time in its history.

E. M. ELIASSEN, Aarstad pr. Bergen, Norway, is in the market for machinery and appliances for machine blacksmithing and a drop forge plant, and wishes to receive catalogues and prices from reliable makers of these lines.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa., has received an order from the New York, New Haven and Hartford R. R. Co., for twelve 113-ton articulated truck type locomotives equipped with 8-408-C motors with type USB control.

MICHIGAN TWIST DRILL CO., 1215-1219 Bellevue Ave., Detroit, Mich., reports that its factory is being operated day and night in order to supply its rapidly increasing business in high-speed and carbon twist drills, reamers and milling cutters.

ST. LOUIS MACHINE TOOL CO., 1209-11 Gratiot St., St. Louis, Mo., has sold its Coe drill and St. Louis drill patterns to the Perry Machine Tool Co., Perry, Mich., and will hereafter devote its energies exclusively to developing its line of grinding and tapping machinery.

CINCINNATI PRECISION LATHE CO., Cincinnati, Ohio, has been incorporated with $50,000 capital stock to manufacture a precision lathe designed by J. M. Tatman. The officers of the company are M. H. Stewart, president, W. C. Tatman, secretary, and J. M. Tatman, vice-president and general superintendent.

ADAMS-BAGNALL ELECTRIC CO., Cleveland, Ohio, has opened a Boston office under the management of Mr. E. R. Bryant, formerly connected with the company's New York office. The company will carry a stock of all its lines in Boston, and hopes in this manner to render its New England trade an improved service.

PERRY MACHINE TOOL CO., Perry, Mich., has purchased the Coe drill and St. Louis drill patterns owned by the St. Louis Machine Tool Co., St. Louis, Mo. Mr. H. G. Porter and associate compose the Perry Machine Tool Co. Mr. Porter, who is a well-known mechanical man of ability, intends to develop the drill business extensively.

TREADWELL MFG. CO., Easton, Pa., has installed an electric furnace in its new plant for the manufacture of steel castings. The electric furnace for the production of steel castings is new in America, although it has been in use about seven years in Europe, where there are now over one hundred electric furnaces in use. Electric furnace steel can be made with any carbon content, with phosphorus content reduced if desired to 0.01 to 0.02 per cent, and the sulphur content within the same limits.

CARBORUNDUM CO., Niagara Falls, N. Y., has been advised through the Department of the Interior at Washington that the Grand Prize for the exhibit of abrasive materials has been awarded by the Jury of Awards of the Turin Exposition to the Carborundum Co. The great Italian Exposition was held from April 15 to October 31, 1911, and many American manufacturers were represented. The carborundum exhibit showed a complete line of carborundum wheels, aloxite wheels, carborundum dental wheels, carborundum sharpening stones and razor hones of all descriptions.

READING STEEL CASTING CO., Reading, Pa., and the Bayonne Steel Casting Co., Bayonne, N. J., were consolidated December 1 under the name of the Reading-Bayonne Steel Casting Co. The officers of the new company are: Wm. D. Sargent, chairman of the board of directors; J. Turner Moore, president; A. E. Williamson, vice-president; and D. W. Yeckley, secretary and treasurer, all of whom have been engaged in the steel casting industry for many years. The new company has an authorized capital of $750,000. The combined capacity of the two plants is from 800 to 1000 tons per month, and both are well located for serving the Schuylkill Valley and Greater New York districts. Both companies have large thoroughly equipped plants for the manufacture of medium and light weight Tropenas steel castings.

NATIONAL AUTOMOBILE SHOW of automobiles and commercial vehicles will be held in the new Grand Central Palace, January 10 to 17. The management has secured quarters which in beauty, area of floor space, convenience and safety are an improvement upon any exhibition building heretofore existing in New York City. The building is located only a few blocks north of the New York Central station and fronts on Lexington Avenue, between 46th and 47th streets. It occupies a block 200 feet by 275 feet, and reaches to the height of thirteen stories. It is built of gray stone and brick construction with a steel skeleton, and cost nearly $1,750,000 including the ground on which it stands. Further information can be obtained from Mr. H. W. Perry, manager of the publicity department, truck section, 7 East 42nd St., New York City.

YOUNGSTOWN SHEET & TUBE CO., Youngstown, Ohio, has recently placed an order with the Westinghouse Electric & Manufacturing Co., East Pittsburg, Pa., for a total of ninety-nine motors to be used in connection with its open hearth plant. The motors will be used on cranes, charging machines, strippers, transfer tables, screw downs, and blooming mills. The Youngstown Co. formerly used the Bessemer process, and is now installing the open hearth process and blooming mill for taking care of the open hearth process output. An interesting point of this order is that fifty-six of these motors are of the new Westinghouse type M. C. direct-current mill type motor equipped with commutating poles. This line has been designed to parallel the well-known M. T. alternating-current motor which has proved so successful in mill service.

LUMEN BEARING CO., Buffalo, N. Y., recently made the following changes in its organization: H. P. Parrock, formerly Western representative, has been appointed sales manager, succeeding Allen Kendall, resigned; H. F. Russell, formerly purchasing agent, has been appointed sales representative, covering central and western New York and eastern Pennsylvania; Albert Lockwood succeeds him in the office of purchasing agent; Louis S. Jones, for many years with the Prentiss Tool & Supply Co., has been appointed sales representative in New England; H. O. Schwaner has been appointed sales representative in the Pittsburg district; Fred Ganderton, formerly with the Aluminum Casting Co., has been appointed sales manager of the Toronto plant. The business of the company is growing to such an extent that it has been found necessary to materially enlarge the organization both in its selling and operating forces. Recent additions and improvements have been made both in the Buffalo and Toronto plants.

*American Industries*, 30 Church St., New York, contains, in the December number, an analysis of business conditions prepared by the editor, Mr. Henry Harrison Lewis. Letters were sent to 10,000 manufacturers and business men, including the members of the National Association of Manufacturers. The replies representing the various industries are tabulated. Practically every industry closely allied with railroad construction is depressed. These include structural iron and steel, lumber, paints and varnishes, cement and clay, plate and window glass, builders' hardware, woodworking machinery and iron-working machinery. Industries directly connected with the manufacture of necessities, such as cereals and their by-products, preserved foods, and sugar and its by-products are practically normal. The conditions in the agricultural implements are unsatisfactory notwithstanding the apparent general prosperity of the farming community. The inferences drawn from the replies of changes required are as follows: 1. Cessation of political agitation. 2. Cessation of tariff agitation. 3. Amendment or improvement of the Sherman Act.

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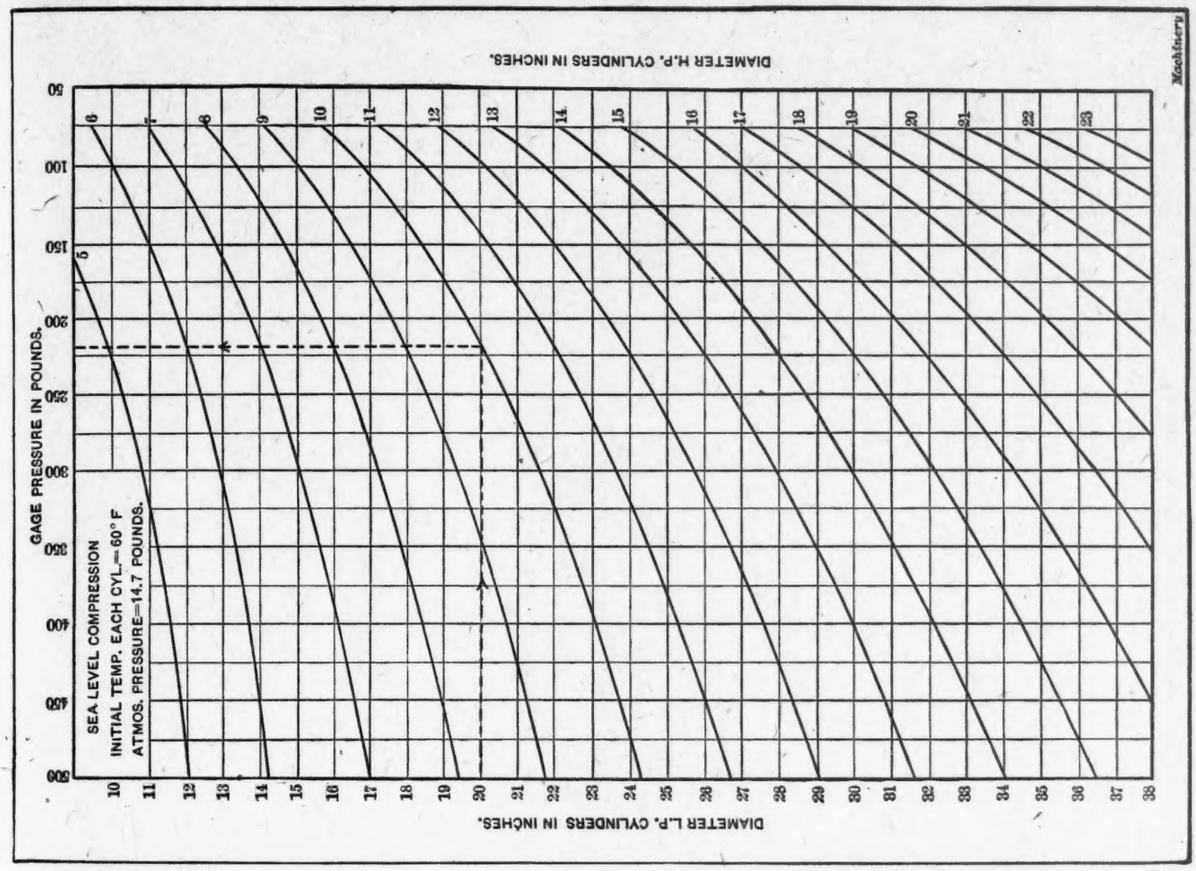
## PRESSURES AT WHICH WORK IS EQUAL IN TWO-STAGE AIR COMPRESSORS—I

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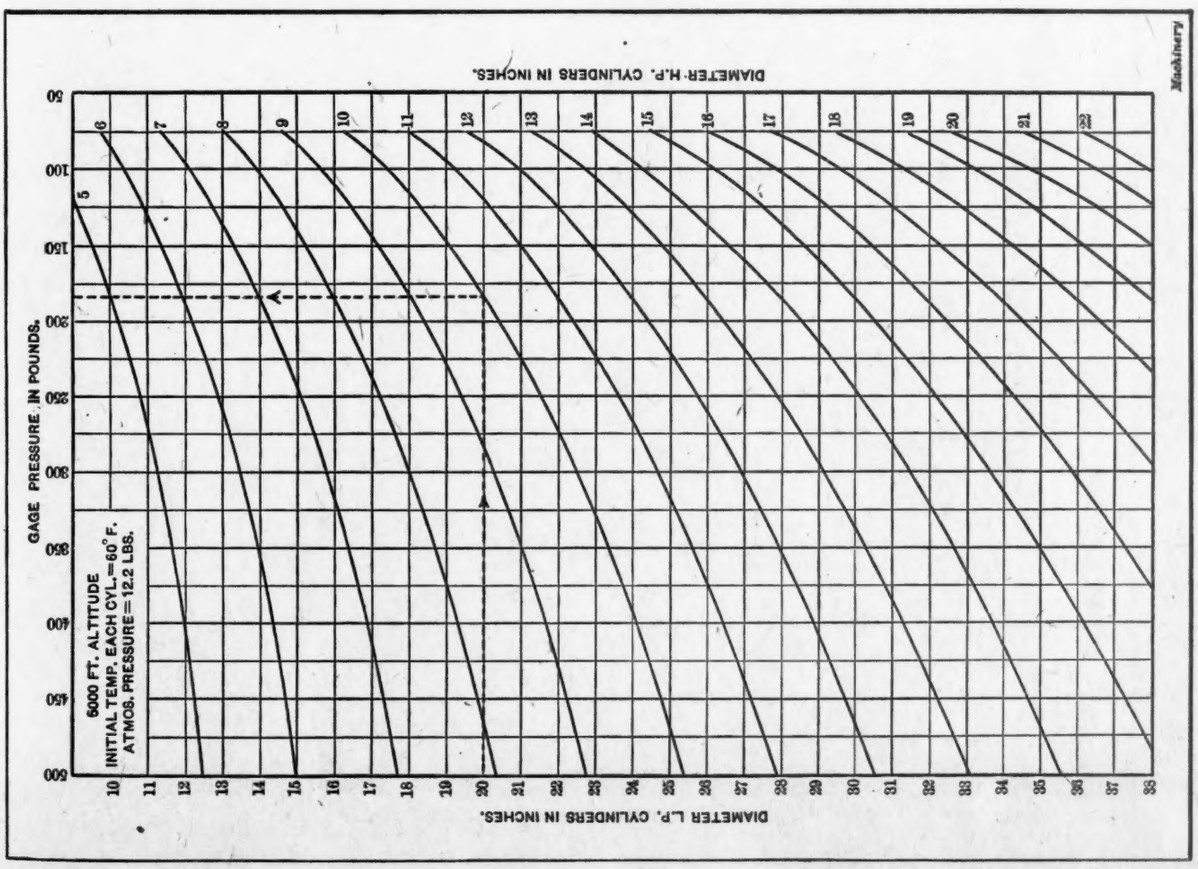
No. 150, Data Sheet, MACHINERY, January, 1912

## PRESSURES AT WHICH WORK IS EQUAL IN TWO-STAGE AIR COMPRESSORS—II

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No. 150, Data Sheet, MACHINERY, January, 1912

## PROPERTIES OF DOUBLE-ANGLE COLUMNS

Contributed by Edmund B. La Salle

| Size Angles, Inches | Area Section, Inches | Moment of Inertia, Axis 1-1 | Section Modulus, Axis 1-1 | Radius of Gyration | | Weight per Foot, Pounds | Length for 125 Least Radii | |
|---|---|---|---|---|---|---|---|---|
| | | | | Axis 1-1 | Axis 2-2 | | Feet | Inches |
| 4 × 4 × 5/16 | 4.80 | 13.42 | 3.36 | 1.67 | 1.54 | 16.4 | 16 | 0 |
| 4 × 4 × 3/8 | 5.72 | 16.14 | 4.04 | 1.67 | 1.54 | 19.6 | 16 | 0 |
| 5 × 5 × 3/8 | 7.22 | 31.23 | 6.24 | 2.08 | 1.95 | 24.6 | 20 | 3 |
| 5 × 5 × 7/16 | 8.36 | 36.66 | 7.33 | 2.09 | 1.95 | 28.6 | 20 | 3 |
| 5 × 5 × 1/2 | 9.50 | 41.92 | 8.38 | 2.10 | 1.94 | 32.4 | 20 | 2 |
| 6 × 6 × 3/8 | 8.72 | 54.24 | 9.04 | 2.49 | 2.34 | 29.8 | 24 | 4 |
| 6 × 6 × 7/16 | 10.12 | 63.24 | 10.54 | 2.50 | 2.34 | 34.4 | 24 | 4 |
| 6 × 6 × 1/2 | 11.50 | 72.28 | 12.04 | 2.50 | 2.33 | 39.2 | 24 | 3 |
| 6 × 6 × 9/16 | 12.86 | 81.74 | 13.62 | 2.51 | 2.32 | 43.8 | 24 | 2 |
| 6 × 6 × 5/8 | 14.22 | 90.88 | 15.15 | 2.52 | 2.31 | 48.4 | 24 | 1 |
| 8 × 8 × 1/2 | 15.50 | 171.60 | 21.45 | 3.32 | 3.15 | 52.8 | 32 | 9 |
| 8 × 8 × 9/16 | 17.36 | 192.96 | 24.12 | 3.33 | 3.14 | 59.2 | 32 | 8 |
| 8 × 8 × 5/8 | 19.22 | 214.42 | 26.80 | 3.34 | 3.13 | 65.4 | 32 | 7 |

**Double-column Formulas for Unit Strength**

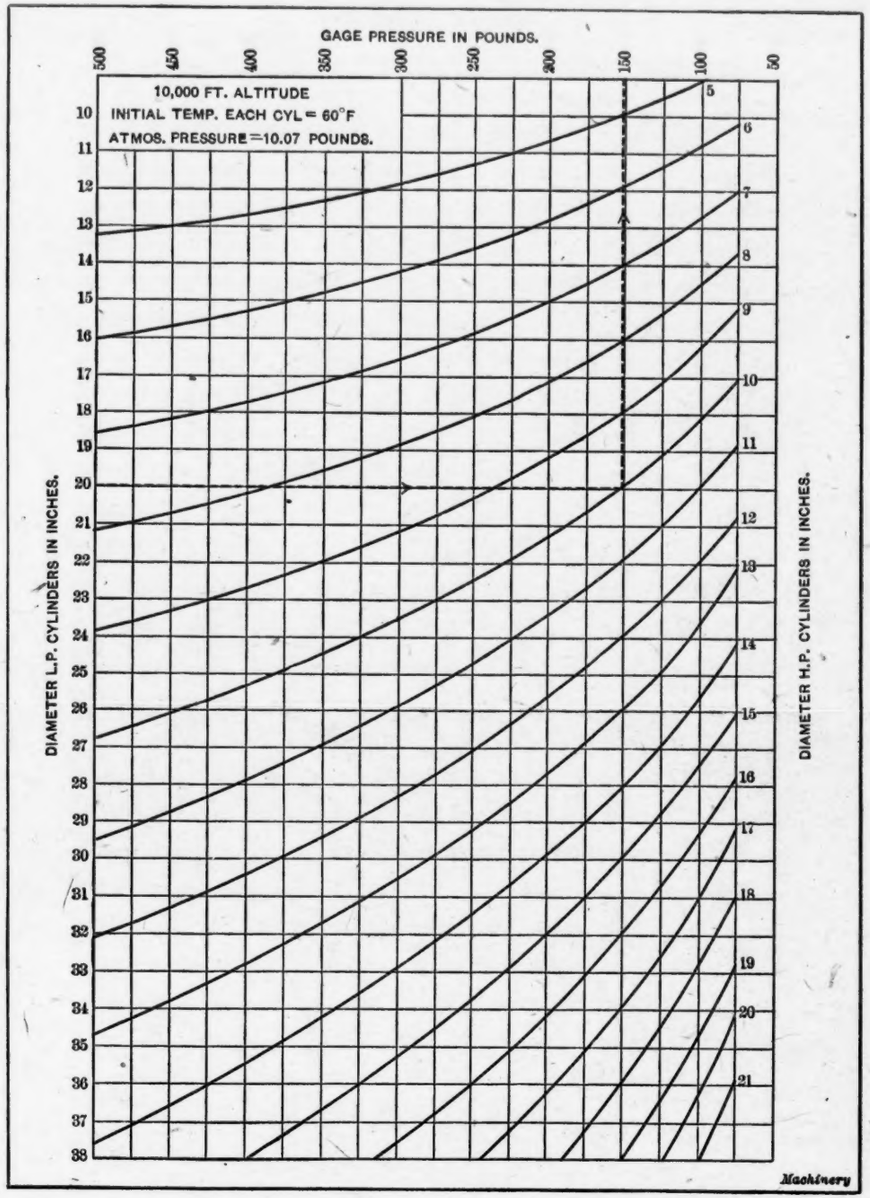
$$17100 - 57\frac{L}{R} \text{ (Carnegie Handbook)}$$

$$16000 - 70\frac{L}{R} \text{ (Maintenance of Way)}$$

No. 150, Data Sheet, MACHINERY, January, 1912

## PRESSURES AT WHICH WORK IS EQUAL IN TWO-STAGE AIR COMPRESSORS—III

Contributed by J. William Jones

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